Report

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FINAL FEASIBILITY STUDY
NL Industries, Inc. Site
Pedricktown, New Jersey

NL INDUSTRIES, INC.
Hightstown, New Jersey

May 1993

O'BRIEN & GERE
ENGINEERS, INC.

NLI 002 0558

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FINAL FEASIBILITY STUDY
NL INDUSTRIES, INC. SITE
PEDRICKTOWN, NEW JERSEY

NL INDUSTRIES, INC.
Hightstown, New Jersey

MAY 1993

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NL INDUSTRIES, INC. SITE
Pedricktown, New Jersey

FINAL FEASIBILITY STUDY

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EXECUTIVE SUMMARY

Overview

The NL Industries, Inc. site (Site) in Pedricktown, New Jersey is the location of a former secondary lead smelting facility. Metal smelting, refining and associated activities were conducted at the Site since the facility was constructed in 1971-1972 until operations ceased in January 1984. A Remedial Investigation Report on the Site was approved by United States Environmental Protection Agency (USEPA) on July 3, 1991.

Two operable units have been identified for the Site. Operable Unit One consists of the Site exclusive of the paved manufacturing area. Operable Unit Two addresses the paved manufacturing area and buildings, and the materials located therein. The USEPA Region II conducted a Focused Feasibility Study during 1991 and issued a Record of Decision for Operable Unit Two on September 27, 1991. This Feasibility Study addresses Operable Unit One.

This Feasibility Study represents a revision of the Draft Feasibility Study Report in response to comments received from the USEPA. The Feasibility Study has been developed, at the direction of the USEPA, utilizing selected assumptions regarding response objectives and the characteristics of the affected soil.

This Feasibility Study addresses the affected media in Operable Unit One, and:

- summarizes the results of the Remedial Investigation and supplemental investigations;
- identifies remedial action objectives;
- develops remedial alternatives;

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- evaluates those alternatives; and,
- incorporates modifications to the Interim Feasibility Study Report (February 1992) based on comments received from the USEPA in its letter dated December 4, 1992.
- incorporates modifications to the Draft Feasibility Study Report (February 1993) based on comments received from the USEPA in its letter dated March 19, 1993.

A summary of the Feasibility Study is presented below.

<u>Remedial Investigation/Supplemental Investigations</u>

<u>Soil:</u> On-site soils contain lead in concentrations ranging from 19 to 12,700 ppm. Off-site soils contain lead in concentrations less than 500 ppm, with the exception of two localized off-site areas.

<u>Ground Water:</u> Site wells solely within the first and second confined aquifers meet USEPA and New Jersey Maximum Contaminant Levels (MCL), as do off-site monitoring wells and private potable wells along U.S. Route 130. On-site monitoring wells in the unconfined aquifer demonstrate concentrations of metals, particularly lead and cadmium, in excess of USEPA MCL and New Jersey ground water standards. On-site monitoring wells at one Site area demonstrate concentrations of volatile organic compounds in excess of New Jersey ground water standards. At another site area, wells exhibit gross alpha and gross beta levels above New Jersey ground water standards.

<u>Sediments:</u> Surface water in the stream along the west edge of the property (West Stream) and south of U.S. Route 130 contains lead concentrations ranging from 49 ppb to 2,200 ppb. Figure 19 shows surface water data for lead. Samples of West Stream surface sediment in the same area ranged in lead concentration from 702 ppm to 26,800 ppm; samples at a

depth of 12 inches averaged approximately 15 ppm. Surface water in the stream on adjacent properties to the east (East Stream) contain lead concentrations ranging from 4 ppb to 101 ppb. Samples of East Stream surface sediment ranged in lead concentration from non-detectable to 4350 ppm; samples at a depth of greater than six inches averaged approximately 1 ppm. The USEPA has specified criteria for lead of 500 ppm to 1,000 ppm in sediments. The East and West Streams merge north of U.S. Route 130. The Corps of Engineers' drainage channel located north of U.S. Route 130 contains lead concentrations in surface water and in the sediments well below concentrations observed in the West Stream south of U.S. Route 130.

Remedial Action Objectives

The following remedial action objectives are identified and supported in this Feasibility Study:

Soil:	500 and 1000 ppm lead in soil and wetland soils. At the direction of the USEPA, both remedial action objectives are to be evaluated for all soils in each remedial alternative. However, it is justifiable based on the Site Ecological Assessment conducted by the USEPA, and the USEPA directive (September 7, 1989) concerning lead remediation, to evaluate a remedial scenario consisting of an on-site action level of 1,000 ppm, and an off-site and wetlands action level of 500 ppm. Alternative H is an illustration of this type of dual remedial cleanup criteria.
Ground Water:	Practical Quantitative Limit (PQL) for lead of 10 ppb.
Sediment:	500 and 1,000 ppm lead in sediment.

Remedial Alternatives

Media-specific alternatives were developed for Site soil, sediment, and ground water. The media-specific approach simplifies alternative evaluation and is appropriate because the media at this Site are relatively independent. The alternatives are as follows:

Soil Alternative A - No Action/Institutional Controls: Institutional controls would be implemented, including fencing and deed restrictions.

Soil Alternative B - Excavation of All Soils Above Action Level/Soil Washing of All Excavated Soil/Return Treated Soils to Site/Disposal: Soils not meeting the response objectives will be excavated. Excavated soils will be subjected to soil washing. Washed soil meeting response objectives will be backfilled. Washed soil that is hazardous will be further treated by off-site solidification/stabilization. Solidified soils will be managed off-site.

Soil Alternative C - Excavation of All Soils Above Action Level/Solidification/Stabilization (S/S) of All Excavated Soil/On-Site Consolidation: Soils not meeting the response objectives will be excavated. All excavated soils will be treated on-site by solidification/stabilization followed by on-site consolidation.

Soil Alternative D - Excavation of All Soils Above Action Level/Soil Washing of Hazardous Soils Requiring Treatment/Consolidation On-Site/Disposal: Soils not meeting response objectives would be excavated. Excavated soils which are non-hazardous [pass Toxicity Characteristics Leaching Procedure (TCLP)] will be consolidated on-site. Excavated soils which are hazardous but land-disposable (fail TCLP, pass EP Toxicity) will be transported off-site for disposal at a permitted hazardous waste landfill. Excavated soils which are hazardous and require treatment (fail TCLP, fail EP Toxicity) will be subjected to soil washing. Washed soils meeting response objectives will be consolidated on-site along with excavated non-hazardous soils. Washed soils that are hazardous will be further treated by off-site solidification/stabilization. Solidified soils will be managed off-site.

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Soil Alternative E - Excavation of All Soils Above Action Level/On-Site S/S of All Hazardous Non-Land Disposable Soil Requiring Treatment/Off-Site Disposal: Soils not meeting response objectives will be excavated. Excavated soils which are non-hazardous will be consolidated on-site. Excavated soils which are hazardous but pass the EP Toxicity Test will be transported off-site for disposal at a hazardous waste landfill. Excavated soil which is hazardous and does not pass the EP Toxicity Test will be treated on site via S/S as described in Soil Alternative C. The solidified/stabilized soils will then be disposed of off-site.

Soil Alternative F - Excavation of All Soils Above Action Level/On-Site S/S of Hazardous Soils/Consolidation On-Site: Soils not meeting response objectives will be excavated. Excavated soils which are non-hazardous (pass TCLP) will be consolidated on-site. Excavated soils which are hazardous (fail TCLP) will be subjected to on-site S/S. The solidified soil will then be consolidated on-site along with excavated non-hazardous soils.

Soil Alternative G - Excavation of All Soils Above Action Level/Off-Site Disposal: Soils not meeting response objectives will be excavated and disposed of at an appropriate, permitted landfill based on soil characteristics.

Soil Alternative H - Excavation of On-Site Soils Over 1,000 ppm Lead and Off-Site and Wetland Soils Over 500 ppm Lead/On-Site Consolidation/Disposal: On-site soils not meeting on-site response objectives (1,000 ppm lead) will be excavated. Off-site soils and wetland soils not meeting off-site or wetlands response objectives (500 ppm lead) will be excavated. On-site excavated soils which are non-hazardous will be consolidated on-site. On-site excavated soils which are hazardous but pass EP Toxicity Testing will be transported off-site for disposal at a hazardous waste landfill.

On-site excavated soils which are hazardous and fail EP Toxicity Testing will be treated on-site either via S/S or soil washing. Washed soil with a lead concentration less than 1,000 ppm will be placed as backfill on-site. Off-site and wetland excavated soils with lead concentrations below 1,000 ppm will be transported on-site and used as backfill. Off-site and wetland excavated soils with lead concentrations greater than 1,000 ppm will be managed along with on-site excavated soils.

<u>Ground Water Alternative A - No Action:</u> Institutional controls will be implemented, including fencing, deed restrictions, and monitoring.

<u>Ground Water Alternative B - Pump and Treat with Subsurface Discharge to Infiltration Pond:</u> Ground water from the unconfined aquifer will be recovered using an existing well point system. Recovered water will be treated by precipitation/ion exchange and discharged to an infiltration pond. Ground water discharge to the unconfined or confined aquifer will have to meet the PQL for lead of 10 ppm.

<u>Ground Water Alternative C - Pump and Treat with Subsurface Discharge to Leach Field:</u> Ground water from the unconfined aquifer will be recovered using an existing well point system. Recovered water will be treated by precipitation/ion exchange and discharged to the unconfined aquifer via leach field.

<u>Ground Water Alternative D - Pump and Treat with Subsurface Discharge via Infiltration Trenches:</u> Ground water from the unconfined aquifer will be recovered using an existing well point system. Recovered water will be treated by precipitation/ion exchange and discharged to the unconfined aquifer via infiltration trench.

Ground Water Alternative E - Pump and Treat with Subsurface Discharge via Reinjection Wells to the Unconfined Aquifer: Ground water from the unconfined aquifer will be recovered using an existing well point system. Recovered water will be treated by precipitation/ion exchange and discharged to the unconfined aquifer via reinjection wells.

Ground Water Alternative F - Pump and Treat with Subsurface Discharge via Reinjection wells to the Confined Aquifer: Ground water from the unconfined aquifer will be recovered using an existing well point system. Recovered water will be treated by precipitation/ion exchange and discharged to the confined aquifer via reinjection wells.

Ground Water Alternative G - Pump and Treat with Direct Discharge to Surface Water: Ground water from the unconfined aquifer will be recovered using an existing well point system. Recovered water will be treated to meet required discharge criteria and discharged to surface water [East or West Stream (discharge criteria for lead may be below 10 ppb) or the Delaware River (discharge criteria for lead may be greater than 10 ppb)].

Sediment South of U.S. Route 130 Alternative A - No Action: Surface water quality in the East and West Streams will be monitored.

Sediment South of U.S. Route 130 Alternative B - Temporary Stream Diversion: Sediments with over 1,000 ppm or 500 ppm lead in the West Stream south of U.S. Route 130 would be excavated. Sediments would be managed in accordance with the selected soil alternative. The West Stream would be temporarily diverted during remediation. The East Stream immediately south of the railroad tracks will be similarly remediated.

Sediment South of U.S. Route 130 Alternative C - Permanent Stream Diversion: The stream segments of the West Stream south of U.S. Route 130 with sediments over 1,000 ppm or 500 ppm lead would be permanently diverted into new channels. The original channel would be excavated to meet soil response objectives. Sediments would be managed in accordance with the selected soil alternative. The East Stream south of the railroad tracks will be similarly remediated.

Sediment North of U.S. Route 130 Alternative A - No Action: Due to the complexity of the stream systems, the possibility of recontamination from the dredge spoils piles, and the risks associated with sediment remediation as highlighted in the USEPA Draft Risk Assessment (January 1993), no remedial actions are proposed in this alternative. However, surface water quality will be monitored in the stream systems North of U.S. Route 130.

Sediment North of U.S. Route 130 Alternative B - Mechanical Dredging: Sediments with over 1,000 ppm or 500 ppm lead in stream segments north of U.S. Route 130 would be excavated. Sediments would be disposed off-site or deposited within the Corps of Engineers dredge spoil piles.

Evaluation of Soil Alternatives:

Soil Alternative A - No Action/Institutional Controls would not be protective of human health, or the environment. Total Estimated Cost: $179,400.

Soil Alternative B - Excavation of All Soils Above Action Level/Soil Washing of All Excavated Soil/Return Treated Soils to Site/Disposal: would be protective of human health and the environment and would meet Applicable or Relevant and Appropriate Requirements (ARARs). Soil washing would remove some of the lead contamination from the soil. Solidification/Stabilization of washed soil that is hazardous would minimize the potential for

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contaminants leaching. Off-site S/S and disposal of treated soils which fail TCLP would remove impacted soils from the site. The alternative would be effective in the long term, however, material handling problems typically associated with soil washing could impede the effectiveness of this alternative. Furthermore, the available data to date has failed to demonstrate that soil washing would be effective for soils below 1,000 ppm lead. This alternative could be readily implemented with minimal disruption to the community or the environment.

Total Estimated Cost: $13,508,000 (1000 ppm response); $19,485,000 (500 ppm response).

Soil Alternative C - Excavation of All Soils Above Action Level/Solidification/Stabilization (S/S) of All Excavated Soil/On-Site Consolidation: would be protective of human health and would meet ARARs. Solidification/Stabilization would immobilize the contaminated soil and minimize the potential for contaminants to leach from the solidified/stabilized mass. Consolidation on-site disposal of solidified/stabilized soils would prevent direct contact and off-site migration of contaminants through surface runoff, weathering, and leaching of contaminants. The S/S of soil will result in increasing the volume of soils requiring disposal by 50 percent. This alternative would be effective in the long term. This alternative could be implemented with minimal disruption to the community or the environment.

Total Estimated Cost: $7,444,000 (1000 ppm response); $10,416,000 (500 ppm response).

Soil Alternative D - Excavation of All Soils Above Action Level/Soil Washing of Hazardous Soils Requiring Treatment/Consolidation On-Site/Disposal: would be protective of human health and would meet ARARs. Soil washing would remove a majority of lead contamination from the soil. Consolidating non-hazardous soils and treated soils beneath an on-site cap with a bottom liner to the east of the fenced landfill would prevent direct contact and off-site migration of contaminants through surface run-off, weathering and leaching of contaminants. Solidification/Stabilization of washed soil that is hazardous would minimize potential for contaminants leaching. Off-site S/S and disposal of treated soils which fail TCLP would remove impacted soils from the site. The alternative would be effective in the long term, however, material handling problems typically associated with soil washing could impede the effectiveness of this alternative. Furthermore, the available data to date has failed to demonstrate that soil washing would be effective for soils below 1,000 ppm lead. This alternative could be readily implemented with minimal disruption to the community or the environment.

Total Estimated Cost: $8,867,000 (1000 ppm response); $10,460,300 (500 ppm response).

Soil Alternative E - Excavation of All Soils Above Action Level/On-Site S/S of Hazardous Soils Requiring Treatment/Off-Site Disposal: would be protective of human health and would meet ARARs. Solidification/Stabilization of hazardous soils would immobilize the contaminated soils and minimize the potential for contaminants to leach from the solidified/stabilized mass. Off-site disposal of hazardous soils not requiring treatment will remove impacted soils from the site. Consolidating non-hazardous and solidified soils beneath a cap with a bottom liner to the east of the fenced landfill would prevent direct contact and off-site migration of contaminants through surface run-off, weathering and leaching of contaminants. This alternative would be effective in the long term and could be implemented with minimal disruption to the community or the environment.

Total Estimated Cost: $8,305,000 (1,000 ppm response); $9,142,000 (500 ppm response).

Soil Alternative F - Excavation of All Soils Above Action Level/On-Site S/S of Hazardous Soils/Consolidation On-Site: would be protective of human health and would meet ARARs. Solidification/Stabilization of hazardous soils would immobilize the contaminated soils and minimize the potential for contaminants to leach from the solidified/stabilized mass. Consolidating non-hazardous and solidified soils beneath a cap to the east of the fenced landfill would prevent direct contact and off-site migration of contaminants through surface run-off, weathering and leaching of contaminants. This alternative would be effective in the long term and could be implemented with minimal disruption to the community or the environment.

Total Estimated Cost: $5,188,000 (1,000 ppm response); $6,128,000 (500 ppm response).

Soil Alternative G - Excavation of All Soils Above Action Level/Off-Site Disposal would be protective of human health and the environment and would meet ARARs. Although effective in the long term, placing soil in landfills would displace other municipal and hazardous solid waste. The alternative could be readily implemented; however, some disruption to the community might occur as the alternative requires significant off-site transport of materials. Total Estimated Cost: $9,307,000 (1000 ppm response); $11,582,000 (500 ppm response).

Soil Alternative H - Excavation of On-Site Soils Over 1,000 ppm Lead and Off-Site and Wetland Soils Over 500 ppm Lead/On-Site Consolidation/Disposal: would be protective of human health and the environment and would meet ARARs. Treating of hazardous soils which fail EP Toxicity would either remove or immobilize the lead contamination. Consolidating non-hazardous soils beneath an on-site cap to the east of the fenced landfill would prevent direct contact and off-site migration of contaminants through surface run-off, weathering and leaching of contaminants. Using excavated wetland and off-site soils as on-site backfill if appropriate, would conserve landfill space and treatment resources. This alternative would be effective in the long term and would cause minimal disruption to the community. For illustrative purpose, this alternative was conservatively costed using soil washing as a treatment technology, instead of S/S which is more economical.

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Furthermore, the cost estimate conservatively assumes that soil washing will have to achieve a treatment objective of 500 ppm rather than 1,000 ppm before backfilling on-site.

Total Estimated Cost: $9,641,000

Evaluation of Ground Water Alternatives

Ground Water Alternative A - No Action would not be protective of human health and the environment and would not meet ARARs. Total Estimated Cost: $60,000.

Ground Water Alternative B - Pump and Treat with Subsurface Discharge via Infiltration Pond would be protective of human health and the environment and would meet ARARs. Preliminary calculations indicate a 10 acre infiltration pond will be required, which is not available on-site. The treatment technology is readily implementable; however, bench scale testing would be required to verify its effectiveness in achieving effluent limitations. Total Estimated Cost: $11,933,000.

Ground Water Alternative C - Pump and Treat with Subsurface Discharge via Leach Field would be protective of human health and the environment and would meet ARARs. Preliminary calculations indicate a 30 acre leach field will be required, which is not readily available. The treatment technology is readily implementable; however bench scale testing would be required to verify its effectiveness in achieving effluent limitations.

Total Estimated Cost: $13,094,000.

Ground Water Alternative D - Pump and Treat with Subsurface Discharge via Infiltration Trenches would be protective of human health and the environment and would meet ARARs. Preliminary calculations indicate an area of 20 acres is required, which is not readily available. The treatment technology is readily implementable; however, bench scale testing would be required to verify its effectiveness in achieving effluent limitations. Total Estimated Cost: $12,112,000.

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Ground Water Alternative E - Pump and Treat with Subsurface Discharge via Reinjection Wells to the Unconfined Aquifer would be protective of human health and the environment and would meet ARARs. The implementation of this alternative could result in a significant mounding effect, which would adversely impact surface structures and the landfill area. The treatment technology is readily implementable; however bench scale testing would be required to verify its effectiveness in achieving effluent limitations. Total Estimated Cost: $12,017,000.

Ground Water Alternative F - Pump and Treat with Subsurface Discharge via Reinjection Wells to the Confined Aquifer would be protective of human health and the environment and would meet ARARs. The treatment technology is readily implementable and bench scale evaluation to-date has shown that a lead level of 10 ppb can be achieved through the treatment. This level is consistent with the State of New Jersey Antidegradation Policy. However, bench scale testing would be required to verify its effectiveness in achieving effluent limitations.
Total Estimated Cost: $11,498,000.

Ground Water Alternative G - Pump and Treat with Direct Discharge to Surface Water would be protective of human health and the environment and would meet ARARs. The treatment technology is readily implementable; however, bench scale testing would be required to verify its effectiveness in achieving a direct discharge effluent limitation which could be more stringent than that required for subsurface discharge as described for Ground Water Alternatives B through F. Total Estimated Cost: $11,592,000 for East and West Stream Discharge and $10,093,000 for Delaware River Discharge.

Sediment South of U.S. Route 130 Alternative A - No Action would not be protective of human health and the environment and would not meet ARARs. Total Estimated Cost: $209,000.

Sediment South of U.S. Route 130 Alternative B - Temporary Stream Diversion would be protective of human health and the environment and would meet ARARs. Excavating sediments could be difficult in some portions of the West Stream due to access problems associated with heavy equipment. The alternative might have some impact on the community, as some of the work would be conducted off-site.

Total Estimated Cost: $1,245,000 (1,000 ppm response); $1,390,000 (500 ppm response).

Sediment South of U.S. Route 130 Alternative C - Permanent Stream Diversion would be protective of human health and the environment and would meet ARARs. Excavating sediments could be difficult in some portions of the West Stream due to access problems associated with heavy equipment. Response objectives would be more easily attained than with Sediment Alternative B. The alternative might have some impact on the community, as some of the work would be conducted off-site.

Total Estimated Cost: $1,251,000 (1,000 ppm response); $1,398,000 (500 ppm response).

Sediment North of U.S. Route 130 Alternative A - No Action complete information is unavailable as to whether this alternative would be protective of human health or meet ARARs. However, based on potential risks to the environment from remedial activities and the possibility of recontamination from other sources, no action may be considered protective of the existing ecological system. Total Estimated Cost: $170,000.

Sediment North of U.S. Route 130 Alternative B - Mechanical Dredging/Clamshell Excavation would be protective of human health and would meet ARARs. Excavating sediments could be difficult in some portions of the streams north of U.S. Route 130 due to access problems associated with heavy equipment. This alternative might have some impact on the community, as some of the work would be conducted off-site.

Total Estimated Cost: $1,959,000 (1,000 ppm response); $3,502,000 (500 ppm response).

The selected remedy will include an alternative from the soil, ground water, sediments south of U.S. Route 130, and sediments north of U.S. Route 130. alternatives presented. In conjunction with these alternatives, miscellaneous remedial actions have been identified to address a shower tank and a septic tank/absorption field. Long term monitoring of the ground water and sediment is an integral component of each of the evaluated alternatives.

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SECTION 1

SECTION 1 - INTRODUCTION

1.1 Purpose and Organization of Report

The Remedial Investigation (RI) Report was completed for the NL Industries, Inc. Site (Site), Pedricktown, New Jersey (OBG, 1990). The RI Report was approved by the USEPA on July 3, 1991 and through subsequent USEPA Addendum to the RI Report. The Feasibility Study Report, hereinafter referred to as the "Report," documents the formulation and evaluation of remedial alternatives for the Site.

The Report is divided into four sections and includes tables, figures and appendices. A brief overview of each of these sections is provided below.

> Section 1 presents information on the Site, including its history and environmental conditions. This section is intended to summarize information contained in the approved RI Report and information obtained in subsequent investigations. An evaluation of potential Applicable or Relevant and Appropriate Requirements (ARARs) also is presented.
>
> Section 2 presents the remedial objectives, and provides the identification and screening of remedial action alternatives, and related technologies.
>
> Section 3 presents the development of remedial alternatives. This section combines technologies applicable to different media into remedial alternatives addressing all of the remedial objectives. This section also screens the remedial alternatives for effectiveness, implementability, and cost.

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Section 4 presents an evaluation of the alternatives developed in Section 3. Each alternative is evaluated in detail with respect to overall protection of human health and the environment, compliance with ARARs, long term effectiveness, reduction of toxicity, short term effectiveness, implementability, and cost. A comparison of the alternatives is also provided.

Tables have been prepared to summarize data generated as part of this study.

Figures have been prepared to summarize and present key issues.

Appendices have been prepared to provide raw data, calculations, or other materials prepared by O'Brien & Gere Engineers which support the interpretations presented in the Report. Appendices also include tables, reports, or other information prepared by an organization other than O'Brien & Gere Engineers to facilitate understanding of the Report.

1.2 Site Background Information

1.2.1 Site Description

The Site is located in Pedricktown, New Jersey as illustrated on Figure 1. The Site is part of an area zoned for development as an industrial park. This area includes present operations of BF Goodrich and former operations of the following major corporations: Airco; Browning-Ferris Industries; and Exxon, Tomah Division. Currently, construction of a co-generation plant next to the B.F. Goodrich facility is nearing completion. To the north of the industrial area, between the Site and the Delaware River, is a military base and an Army Corps of Engineers dredge spoil area. The industrial park area is bordered by a combination of undeveloped, residential and agricultural lands.

The residences are one or two story, single family homes. Agricultural lands produce a variety of crops, including tomatoes, corn, soybean, and asparagus (USEPA, 1991d).

The Site occupies approximately 43.7 acres and is divided into a northern and a southern section by railroad tracks. The northern section includes a closed RCRA landfill, an office trailer, a storage trailer, and a leachate holding tank. The southern section includes the factory complex and the landfill access road.

1.2.2 Site History

A secondary lead smelter was constructed at the Site in 1971 - 1972 to recycle automotive batteries. The smelter originally made use of a blast furnace and a reverberatory furnace for lead reclamation. A sweater furnace also was used on-site for melting of metallic lead scrap. The facility was upgraded in April, 1978 to incorporate a rotary kiln for smelting of lead-bearing materials.

A RCRA landfill also was constructed on the facility's property, upgrading and replacing a previous landfill. Figure 2 shows the location of this RCRA landfill, in the northern section of the Site and consisting of two phases: Landfill Phase A and Landfill Phase B. Landfill Phase A contains materials from the former on-site landfill (e.g., blast slag) and kiln slag. Landfill Phase B contains kiln slag, hard rubber case material, and lead bearing soils that were excavated from the facility's grounds in 1983. Additional information on the landfill is included in the approved RI Report (O'Brien & Gere Engineers, 1990) and subsequent USEPA Addendum.

NL Industries, Inc. terminated operations on May 25, 1982. On October 6, 1982, NL Industries, Inc. signed an Administrative Consent Order (ACO) with the New Jersey Department of Environmental Protection now known as the New Jersey Department of Environmental Protection and Energy

(NJDEPE). Pursuant to the order, NL Industries, Inc. agreed to carry out environmental remedial activities at the Site. In anticipation of the sale of the property to National Smelting of New Jersey (NSNJ), the order was amended on February 10, 1983 to distribute the responsibilities for these activities between NL Industries, Inc. and NSNJ. The sale occurred later in February 1983.

Prior to the sale to NSNJ, NL Industries, Inc. washed all paved surfaces in the manufacturing area and removed soils in selected areas around the plant to an average depth of 6 inches. An estimated total of 1742 cubic yards of soil was removed. In addition, an estimated 14,500 cubic yards of marsh muds were removed, to an average depth of 24 inches. A ground water abatement system was installed and tested (Ground Technology, 1983). In addition, a $600,000 payment was made to the State of New Jersey in the event that surface/groundwater remedial activities were necessary in the future.

NSNJ commenced rotary kiln smelting on May 20, 1983 and operated the smelter until January 20, 1984. During the operation of the Pedricktown facility by NSNJ, vast quantities of slag waste from the processing of lead, along with other bulk, drummed and/or containerized waste materials, and raw materials (including ore concentrates, fluxes, and reagents) were allowed to accumulate in non-enclosed areas that were exposed to the elements. NSNJ filed for bankruptcy under Chapters 11 and 7 on March 5th and 27th, 1984, respectively. In 1991, USEPA created a second operable unit to examine the effects of on-site slag as well as contaminated buildings, debris, and standing water and to address them on an expedited basis.

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Following bankruptcy filing, the National Bank of Georgia (Trustee for the holders of New Jersey Economic Develop Authority Bonds issued to finance the operations of NSNJ), stationed personnel at the Site for site security and landfill maintenance. The Bank removed its landfill maintenance personnel on June 15, 1984. NL Industries, Inc. voluntarily entered the Site on June 18, 1984 to pump landfill leachate which had accumulated in the leachate sumps, to maintain landfill cover materials, and, generally, to prevent landfill failure. The National Bank of Georgia ceased security services on August 31, 1985 and abandoned the Site.

NL Industries, Inc. has continued to maintain the landfill since 1984. These maintenance activities included two landfill remedial projects to address the impact of adverse weather conditions upon the landfill. USEPA, Region II, and NJDEPE were notified of and consulted with regarding these activities.

NL Industries, Inc. agreed in an Administrative Order on Consent with the USEPA to conduct a RI/Feasibility Study (FS) effective on April 30, 1986. The RI Report was approved by USEPA on July 3, 1991. In approving the RI Report, USEPA commented on a number of activities that were initiated during the RI. In response to some of these comments, sampling and analytical work, and other studies were commenced by NL and USEPA, some of which are still in progress.

1.2.3 Nature and Extent of Contamination

The RI Report presented considerable information on conditions and substances at the Site. Subsequent to the October, 1990 submission of the RI Report to USEPA, additional sampling was conducted during October, November and December 1990. Data obtained by NL Industries Inc. was presented as Volume IV of the RI Report; data generated through sampling by USEPA is included as Appendix A of this report. This subsection is intended to summarize these sources of information and to establish basic information necessary to evaluate remedial options. A discussion on the additional sampling performed in the first quarter of 1993 and the procedures followed to estimate the volumes of soil and sediment to be excavated from the site are contained within Appendix N - Soil and Sediment Volume Calculations.

1.2.3.1 Soils

Soil sampling locations are shown on Figures 3, 4 and 5. Tables 1-1 through 1-3 present the results of analyses. Sample locations which exceed 1000 ppm lead in soil are illustrated on Figure 6; sample locations which exceed 500 ppm in soil are illustrated on Figure 7. A discussion of soil lead concentrations by location is presented below.

Soils on NSNJ Property: Data from soils on NSNJ property are presented on Table 1-1. Surface soils (0-2" and 0-3") have concentrations of lead which average 1645 ppm and range from 19 to 12,700 ppm. The top of the landfill has the lowest lead concentrations due to its relatively recent construction remote location relative to smelting activities, and off-site source of cover materials. Areas adjacent to the manufacturing area contain the highest lead concentrations. These high concentrations appear to have been caused by runoff from slag, dross, and/or debris mounds on plant areas adjacent to the sampling locations.

Soils off NSNJ Property: Data from soils off NSNJ property are presented on Table 1-2. With the exception of one isolated area characterized by sample locations 44, 44A, and 60-64 as illustrated on Figure 5, surface soils (0-3") have lead concentrations which average 114 ppm and range from 22.8 ppm to 685 ppm. Surface soils within the isolated area (0-3") have lead concentrations which average 1244 ppm and range from 844 ppm to 1770 ppm. Concentrations in this area are inconsistent with the overall trend of soil lead levels resulting from airborne desposition decreasing in value as the distance from the Site increases. Sample locations 44, 63 and 64 consist of a low lying marshy area west of the East Stream. The East Stream south of the railroad tracks is not affected by stormwater runoff from the NSNJ property due to topography and distance from the Site. Accordingly, these readings cannot be correlated to runoff from the Site. Thus, the lead concentrations in this area are inconsistent with (i) airborne disposition patterns and the wind rose for the area, and (ii) stormwater runoff patterns. For these reasons, the lead concentrations in this area which are inconsistent with identified air deposition patterns are presumed to be caused by sources not related to the Site.

Lead has been detected in designated wetland areas at the Site. Figure 7.1 shows the wetland areas identified at the Site. Wetland areas AA5, AA6, and AA7 present south of the railroad tracks contain lead concentrations above 500 to 1000 ppm. The Wetland Evaluation Technique (WET) was performed on the wetland areas to provide an assessment of the functional value of the wetlands.

The study area was separated into nine (9) Assessment Areas (AA's) based on physical and biological characteristics. This WET was performed on each area to evaluate the functions of ground water recharge; ground water discharge; flood flow alteration; sediment/toxicant retention; nutrient removal/transformation; production export; wildlife diversity/abundance for breeding, migration and wintering; and aquatic diversity/abundance.

These typical wetland functions and characteristics were evaluated in terms of "effectiveness and opportunity." The WET describes "effectiveness and opportunity" as follows:

> "Effectiveness assesses the capability of a wetland to perform a function due to its physical, chemical, and biological attributes. Effectiveness does not estimate the magnitude at which a function is performed, only the probability that a wetland will perform the function...
>
> Opportunity assesses the chance or opportunity a wetland has to perform a function. For example, a wetland may possess the physical attributes required to perform flood flow alteration, but unless the wetlands is positioned in the watershed where it will receive flood flows it will not have the opportunity to perform the flood flow alteration function."

The WET evaluates the functions of wetlands using predictors that are believed to correlate with the wetland and its surroundings in terms of physical, chemical, and biological characteristics. The conclusions drawn by WET are qualitative probability ratings of High, Moderate, or Low for function in terms of effectiveness and opportunity.

Presented below is a tabular summary of the evaluation results for each assessment area:

	Assessment Area Rating: Effectiveness/Opportunity								
Characteristic	AA1	AA2	AA3	AA4	AA5	AA6	AA7	AA8	AA9
Ground Water Discharge	U/*	L/*	L/*	U/*	L/*	U/*	L/*	U/*	U/*
Ground Water Discharge	L/*	L/*	L/*	L/*	L/*	L/*	L/*	L/*	L/*
Floodflow Alteration	H/M	H/M	M/M	H/M	M/M	H/M	H/M	H/M	H/M
Sediment/Stabilization	M/*	M/*	M/*	M/*	H/*	M/*	M/*	M/*	M/*
Sediment/Toxicant Detention	H/H	H/H	L/H	H/H	H/H	H/H	H/H	L/H	H/[illegible]
Nutrient Removal/Transformation	[illegible]/M	H/L	L/L	L/L	L/L	H/L	L/L	L/M	H/M
Production Export	M/*	M/*	M/*	M/*	M/*	M/*	M/*	M/*	M/*
Wildlife Diversity/Abundance (D/A)	*/*	*/*	*/*	*/*	*/*	*/*	*/*	*/*	*/*
Wildlife D/A Breeding	M/*	M/*	M/*	M/*	M/*	M/*	M/*	M/*	M/*
Wildlife D/A Migration	H/*	L/*	H/*	L/*	L/*	L/*	L/*	L/*	L/*
Wildlife D/A Wintering	L/*	L/*	L/*	L/*	L/*	L/*	L/*	L/*	L/*
Aquatic Diversity/Abundance	H/*	M/*	M/*	L/*	L/*	L/*	[illegible]	M/*	H/*
Uniqueness Heritage	*/*	*/*	*/*	*/*	*/*	*/*	*[illegible]	*/*	*/*
Recreation	*/*	*/*	*/*	*/*	*/*	*/*	*/*	*/*	*/*

NOTE: H = High; M = Moderate; L = Low; U = Unrelated; * = Not Evaluated

As shown in the chart, none of the areas were rated as High or Low for all functions evaluated by WET. In general, the downstream areas received higher ratings for effectiveness than upstream areas, which are closer to the site. The downstream areas are comprised of continuous streams and the portions of the areas which are inundated with water for substantial periods of time. All wetlands except AA1, AA2, and AA9, contain primarily low and moderate effectiveness ratings. A detailed discussion of the WET results is included in Appendix M.

1.2.3.2 Ground Water

Based on the remedial investigation conducted, three hydrogeologic units have been identified. These include:

1. the unconfined (uppermost and water table) aquifer;
2. the first confined aquifer; and
3. the second confined aquifer.

The unconfined aquifer consists primarily of fine to medium sands with interspersed clay layers and lenses. The aquifer is considered to be part of the Cape May Formation and averages approximately 20 ft. in thickness. Groundwater elevations in the unconfined aquifer range from about 3 to 5 feet above MSL. Previous studies conducted have evaluated the shallow and deep zones of this aquifer. The alphabetical designated cluster wells (H through T) were installed for slug test and pumping test purposes used for Groundwater Abatement System design purposes only. Future references to shallow and deep unconsolidated zones are typically related to this well series. Well locations are presented on Figure 8.

The first confined aquifer exist at approximately 50 to 70 feet below grade and consists predominantly of fine to course sand. This aquifer is considered to be part of th[illegible] Raritan formation with ground water elevations ranging from abo[illegible] 5 fe[illegible] below MSL. Gr[illegible]d water is monitored in this formation by well, 9R2, 10R, 12, 16, 20 and 21. The first confined [illegible]ifer and the unconfined aquifer are separated by a clay layer ranging in thickness from abo[illegible] o 20 feet.

The second confined aquifer also consists of Sands from the Raritan Formation. W[illegible]s 8R, 13 and 19 monitor this formation and reflect water level elevations of about 10 to 15 feet below MSL. The second confined aquifer and the first confined aquifer are separated by a clay layer approximately 30 feet in thickness. The thickness of the second confining clay layer and its reported presence on adjacent industrial property (Woodward Clyde, 1989) suggests that this aquitard extends across the site and is regionally extensive. Geologic cross-sections provided as Figures 11 through 15 illustrate the geologic conditions and hydrogeologic units discussed above.

Ground water elevation data is presented on Table 2-1. As shown on Figure 9, ground water flow in the unconfined aquifer is predominantly in a northwest direction; however, discontinuous layers of sands and clays cause localized variations in flow direction. Ground water in the first confined aquifer appears to flow in a westerly direction as shown on Figure 10. Ground water flow in the second confined aquifer appears to be in an northeasterly direction. This suggests that the pumping of industrial supply wells in proximity of the site is influencing the direction of flow [illegible] controlling the second confined aquifer flow under the site.

Monitoring wells at and near the Site are illustrated on Figure 8. The results of gro[illegible] water analysis are summarized in Tables 2-2 through 2-11. A summary of those analytical results is presented below:

Home Owner Supply Wells

Home owner well analyses complied with USEPA drinking water standards for metals and sulfate during both 1988 and 1989 sampling events (Table 2-11). Slight differences in concentrations among wells are likely associated with the different aquifers being pumped. Independently, the USEPA sampled several potable wells along U.S. Route 130, northwest of the Site, on August 17, 1988 and July 22, 1989 (Appendix B). These results indicate that the private potable water wells along Route 130 comply with the USEPA and NJDEPE MCLs. However, some homeowner wells sampled did exceed the PQL of 10 ppb for lead.

USEPA has also sampled home owner wells in 1991. Sampling results indicated that levels of contaminants do not exceed USEPA drinking water standards (USEPA 1992).

Monitoring Wells - Unconfined Aquifer

The following monitoring and observation wells screen the unconfined aquifer and were included for laboratory analyses during the RI program: 1R, 2R2, 3R, 4R, 5R, 6, 7, 11, 15, 17, 18, BR, CR2, HD, HS, ID, IS, JD, KD, KS, LD, MD, MS, ND, NS, OD, PD, QS, RD, RS, SD, SS. Monitor well 14 appears to screen both the unconfined and first confined aquifers. This potential condition will be investigated during remedial design activities. The "S" and "D" designations following this alphabetical well identification above refers to the shallow zone and deep zone of the unconfined aquifer. Seven of the twelve nested pairs (H, K, M, N, Q, R and S) were utilized during the RI to evaluate concentrations based upon location and depth. The terms shallow and deep zones were used in the discussion of concentrations and evaluation of data. These terms related to the screened interval only and not the subsurface material encountered. There is no specific differentiation of geologic material in the upper (shallow zone) and lower (deep zone) depths of the unconfined aquifer. All future reference to these zones relates solely to screen interval as the unconfined aquifer will be addressed as a single hydrogeologic unit. The subsequent discussions of this section under the headings Shallow Zone Ground Water Quality and Deep Zone Ground Water Quality relate to contaminant concentration evaluations and comparisons for the upper (shallow zone) and lower (deep zone) components of this unconfined aquifer.

The analytical results for the unconfinded aquifer monitoring wells sampled during the RI, including the deep zone wells and seven select shallow zone wells, are presented on Table 2 and summarized below:

Filtered Metals:

Groundwater samples from monitoring wells with a turbidity greater than 5 NTUs (40 CFR 141.3) were field filtered through a 0.45 micron filter to determine soluble metal content (see Tables 2-2 and 2-3). A total of 78 of 83 samples were filtered in this way.

In general, the analytical results demonstrate improvement in groundwater quality over time. For example, the following wells which exceeded the NJDEPE groundwater quality criteria Practical Quantitation Limit (PQL) of 10 ppb in 1988 met the PQL in subsequent sampling events: CR2, HD, NS, PD, and OD. This general trend of improvement of groundwater quality over time is also evident by comparing 1983 data (RI Report, Exhibit B) to the data collected from 1988 through 1990. There are minor exceptions to this general trend of improvement. For instance, certain wells display relatively constant cc ntrations of constituents. For example, well SD displayed a cadmium concentration of 10 pb in 1988 and a cadmium concentration of 997 ppb in 1990. Al dmium concentratic in well 11 increased slightly from 134 ppb in 1988 to 213 ppb in 1989.

Unfiltered Metals:

Five groundwater samples had turbidities less than 5 NTUs, and therefore did not require filtering. The five samples ranged in lead concentration from 1 ppb to 24 ppb.

Shallow Zone Ground Water Quality:

Lead concentrations in the shallow zone of the unconfined aquifer are illustrated on Figure 33. For the shallow zone, lead concentrations in the vicinity of the factory complex range from 3130 ppb to 4400 ppb, as indicated by wells KS and HS, respectively.

Cadmium concentrations in the shallow zone of the unconfined aquifer are illustrated on Figure 34. For the shallow zone, cadmium concentrations in the vicinity of the factory complex range from 6 ppb to 173 ppb, as indicated by wells HS and KS, respectively.

Deep Zone Ground Water Quality:

Lead concentrations in the deep zone of the unconfined aquifer are illustrated on Figure 35. For the deep zone, lead concentrations in the vicinity of the factory complex range from 9 ppb to 56 ppb, as indicated by wells HD and SD, respectively. As presented above the analytical results from wells 15 (2.1 ppb) and 17 (2.6 ppb) indicate that groundwater meets the NJDEPE PQL for lead of 10 ppb within 500 feet of the property boundary. Comparison of unconfined aquifer deep zone results to shallow zone results indicates that groundwater quality improves markedly with depth for lead.

Cadmium concentrations in the deep zone of the unconfined aquifer are illustrated on Figure 36. For the deep zone, cadmium concentrations in the vicinity of the factory complex range from 3 ppb to 997 ppb, as indicated by wells ID and SD respectively. Within the deep zone, analytical results from wells LD (2 ppb), 1R (3ppb) and 2R2 (5 ppb) indicate that groundwater meets the USEPA MCL for cadmium of 5 ppb within the property boundary. Cadmium concentrations in the deep zone of the unconfined aquifer tend to be higher than those in the shallow zone.

Three unconfined aquifer locations yielded groundwater samples which were substantially different from the remainder of the Site:

Well 2R2: Well 2R2, located adjacent to the landfill on its northern boundary, showed elevated sulfate and arsenic concentrations. Analytical results from 1990 for these parameters were 2,300 ppm and 4,200 ppb, respectively. The USEPA MCL for arsenic is 50 ppb.

Well SD: Well SD, located adjacent to the factory complex, contained several metals at higher concentrations than other wells. These metals include:

Metal	Typ. Conc. (ppb)	SD	USEPA MCL
Beryllium	3 to 7	156	3 (proposed)
Cadmium	ND to 379	997	5
Chromium	ND to 246	3660	100
Copper	ND to 219	4360	--
Nickel	ND to 140	2480	--
Zinc	18 to 603	8640	--

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Chloroform was also detected in well SD at a concentration of 7 ppb. There is no USEPA MCL or New Jersey Drinking Water Standard for chloroform.

Wells 11 and BR: Wells 11 and BR on the southwest side of the factory complex contain volatile organic compounds in excess of USEPA MCLs and New Jersey drinking water standards. These compounds include:

Compound	Well	Conc*	NJ Std*	USEPA MCL*
1,1,1 trichloroethane	11	2500	26	200
1,1 dichloroethene	11	210	2	7
tetrachloroethene	11	210	1	5
vinyl chloride	BR	76	2	2

* Concentrations in ppb.

Off-Site Unconfined Aquifer Ground Water Quality:

Wells 15 and 17 monitor the unconfined aquifer within 500 feet of the property boundary. These wells are hydraulicly downgradient of the site and screen the full unconfined aquifer. Analytical results for lead at wells 15 and 17 were 2.1 ppb and 2.6 ppb, respectively. Cadmium results for 15 and 17 were 2.1 ppb and <5 ppb, respectively. These results are within the NJDEPE PQL for lead of 10 ppb and the USEPA MCL for cadmium of 10 ppb. Ground water quality, within 500 feet of the property boundary, meet the respective criteria for these parameters of concern.

Monitoring Wells - Confined

Wells 9R2, 10R, 12, 16, 20, and 21 are screened in the first confined aquifer. Lead concentrations in these wells ranged from 1 to 3 ppb, well below theNJDEPE PQL of 10 ppb. Cadmium was not detected in these wells. Concentrations of arsenic ranged from non-detect to 4 ppb, well below the USEPA MCL for arsenic of 50 ppb. Acetone was the only organic compound detected in the first confined aquifer; acetone was detected in well 20 at a concentration of 12 ppb. There is no USEPA or NJDEPE MCL for acetone.

In 1990, well 10, which was screened in both the unconfined aquifer and the first confined aquifer, was removed and sealed with bentonite. A replacement well, well 10R, was installed and screened within the first confined aquifer. Well 10R was sampled in 1990 and found to contain lead at 90 ppb and arsenic at 3 ppb. Cadmium was not detected. The exceedance of the NJDEPE PQL OF 10 ppb could be related to previous cross-migration from the former well 10, now sealed. A sample collected from well 10 in August 1988 contained a lead concentration of 12 ppb. The difference between the 1988 value and the 1990 value (attributed to cross-contamination) may be due to dilution factors from dual aquifer screening. It is anticipated that this localized anomaly will be mitigated with time and natural dilution. Additional monitoring of 10R will serve to evaluate this situation and the anticipated decrease of lead concentration in this location.

Wells 8R, 13 and 19 are screened in the second confined aquifer. Well 8R was not sampled. In 1990, lead concentrations in wells 13 and 19 were 2.3 ppb and 6.1 ppb, respectively. These concentrations are well below the NJDEPE PQL of 10 ppb lead. Cadmium was not detected in the second confined aquifer. Arsenic was detected in well 13 at a concentration of 2.7 ppb, which is well below the USEPA MCL for arsenic of 50 ppb.

In conclusion, with the exception of well 10R as explained above, concentrations of constituents in the confined aquifers are similar to those found in the private wells located along U.S. Route 130. This data demonstrates that USEPA and NJDEPE groundwater standards for the metals and organic compounds analyzed are achieved in the confined aquifers.

<u>Existing Well Point System</u>

In July 1982, NL Industries, Inc. performed an extensive hydrogeologic study of the Site. Clustered observation wells were installed in the shallow and deep zones of the unconfined aquifer, and aquifer characteristics were determined. A ground water recovery system was designed and installed based upon the investigatory activities conducted and the results of controlled pumping tests. A summary of these activities is provided in the May, 1983 Geraghty & Miller, Inc. report entitled "Hydrogeologic Study and Design of Ground Water Abatement System at NL Industries, Inc. Pedricktown, New Jersey Plant Site." The existing well point system (referenced as such throughout this Report) is the recovery well network installed as documented in the May 1983 report. Forty-nine of the fifty-one proposed recovery wells were installed to comprise the "existing well point system" which is discussed in detail in Section 3. This system was designed to prevent off-site migration of contaminated ground water. The existing well point system was tested by Groundwater Technology/Moretrench America following installation, and was found to satisfy the design criteria. During remedial design, the recovery system design, test results, and physical condition will be reviewed to determine if repairs or modifications may be required.

1.2.3.3 Surface Water and Sediment

Data from surface water sampling are presented on Table 3; sampling locations are shown on Figure 3. Appendix C includes color photographs of the West Stream.

Data from the 1988 sampling effort show elevated lead concentrations in surface water on the Site. The highest lead concentrations occur where the West Stream crosses the Site and in the herbaceous wetland adjacent to the railroad tracks. The lowest lead concentrations were found upstream of the Site.

The range in lead concentrations detected in the 13 samples collected from the West Stream and analyzed in 1989 ranged from 48.8 to 2200 ppb with a mean of 446 ppb. Results from the analysis of the two samples collected and analyzed from the East Stream in 1989 were 10 and 101 ppb lead.

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Analysis on 13 surface water samples during 1990 were completed for seven metals (As, Cd, Cr, Cu, Pb, Sb, Zn) and hardness. In addition, one location was analyzed using USEPA SW 846 Methods 8080, 8240 and 8270 for priority pollutant organics. The results demonstrate no detectable antimony, cadmium, or chromium in either the East Stream or West Stream. No organics were detected utilizing the USEPA SW846 Methods 8080, 8240, and 8270.

Figures 16, 17 and 18 present the concentrations of lead, copper and zinc, respectively, during 1990. Other metals were not plotted because they were either not detected, i.e., cadmium, chromium, or antimony, or found at low enough concentrations relative to Ambient Water Quality Criteria (AWQC) and New Jersey Surface Water Standards to be of no ecological concern, i.e., arsenic. To identify whether copper, lead, or zinc could be adversely affecting biota within the streams, both the acute and chronic AWQC were calculated for each of the metals based on measured hardness. The ratio of the metal concentrations detected to AWQC value for that metal provides a measure of the likelihood of an adverse effect on the aquatic biota. A value of less than 1 suggests no effect; a value greater than 1 indicates an effect might be possible. These ratios are:

Metal	Range of Ratios based on AWQC - Chronic	Range of Ratios based on AWQC - Acute
copper	0.4 - 3	0.1 - 2.0
lead	0.9 - 138.6	0.0 - 5.4
zinc	0.7 - 1.9	0.6 - 1.8

As shown in the chart, the largest ratios occurred for chronic and acute effects from lead concentrations.

As shown on Figure 16, analytical results from the 1990 sampling event show decreasing concentrations of lead in surface water with increasing distance downstream from the Site. Specifically, lead concentrations in the West Stream decreased from 206 ppb adjacent to the Site to 9 ppb near the confluence with the Delaware River. The ratio of 1990 surface water data for lead to AWQC (Acute) is presented on Figure 19. As shown on Figure 19, the ratio of 1990 surface water data for lead to the ratio of AWQC (Acute) is significantly less than 1 north of US 130, indicating that acute toxicity would not be anticipated in these segments. Sample results for the East Stream, north of the railroad tracks, also exhibit AWQC (Acute) less than one. Figure 19 also presents the ratio of 1990 surface water data for lead to AWQC (Chronic). As shown on the Figure, the ratio exceeds 1 upstream of sample location EPA-8, indicating the potential for chronic impact on biota in these stream segments.

Because stream sediment can be a secondary source of metals in surface water, via resuspension and partitioning, stream sediment samples were obtained and analyzed in 1988, 1989 and 1990. Analytical data are presented on Tables 4-1 through 4-4; sample locations are illustrated on Figure 3. Figure 20 summarizes the four sets of data for lead.

As shown on Table 4-4, metals such as arsenic, cadmium, chromium, copper, and zinc also were detected in the sediment samples. As shown on the figures included in Appendix L, the concentrations of these metals in sediment tend to be directly proportional to the concentration of lead in sediment, especially where lead concentrations are less than 500 ppm. Therefore, the concentration of lead can be used as an indicator of overall heavy metal concentration in the sediments.

The ranges of lead concentrations detected in surface sediment samples (i.e. uppermost sediment sample) for various stream segments are shown on Figure 21. As shown on the figure, stream sediment lead concentrations are most elevated in the West Stream segment adjacent to the plant site, where sediment lead concentrations range from 1640 ppm to 23,700 ppm. Area background

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would be expected to be between 0 and 91 ppm lead based on USGS data (E.I. du Pont de Nemouis & Co.). In addition, the NJDEPE has assigned a background level of 100 ppm for lead (Technical Basis and Background for Cleanup Standards for Contaminated Sites [N.J.A.C. 7:26D]).

Ecological toxicity-based criteria currently are unavailable to evaluate the potential effects of heavy metals in sediment on biota. USEPA determined that it is appropriate to develop site-specific criteria for lead contaminated stream sediments (USEPA, 1992b). The site-specific study utilized sediments from the site to determine an ecological criteria based on lead concentration. Given the generally linear relationship between lead and the other metals in the sediment, this lead-based approach is justified. Therefore, the remainder of this report will focus on the lead concentration of the sediments.

1.2.3.4 Media Not Included in this Feasibility Study

The RI Report identified several additional contaminated media in the factory complex, and the landfill including:

- Factory Buildings;
- Factory Liquid Wastes;
- Factory Solid Wastes; and
- Landfill Leachate.

The three media associated with the factory complex are presently being addressed by USEPA and the participating respondents to the OU-2 Unilateral Administrative Order, as a separate operable unit (Operable Unit 2) (USEPA, 1991d). The Focused Feasibility Study for Operable Unit 2 addresses the following: debris and contaminated surfaces (including buildings); contaminated standing water; and slag and lead oxide piles (USEPA 1991d). Soils within the factory complex will be addressed as part of OU-1 in this Feasibility Study. The landfill leachate is currently being collected for off-site treatment. Modifications to this approach are not anticipated.

The shower water tank and the septic tank/absorption mounds are areas that may have been impacted by past site activities. During the remedial design phase these areas will be sampled to formulate a specific remedial approach. However, the following activities are likely .

Shower Water Tank: The employee washroom shower water tank will be excavated, rinsed of dirt and grit, and disposed of in a permitted landfill. Drainage or rinsing from the shower tank will be collected and disposed of with the landfill leachate. Soils surrounding the shower tank will be sampled, and if necessary, excavated to meet response objectives. These soils will be managed in the same manner as surface soils identified for remediation.

Septic Tank/Absorption Mounds: The septic tank system has been inactive since 1984. The septic tank will be pumped by a septic system service and rinsed. For aesthetic reasons, the mounded adsorption fields will be graded after grubbing out the distribution piping.

A cost estimate for implementing these activities are included in Sections 3 and 4.

In addition, there are three underground storage tanks at the Site. These tanks were used for motor vehicle fueling. Closure of these tanks is not within the scope of this Feasibility Study.

1.2.4 Contaminant Fate and Transport

The RI Report presented a detailed discussion on the migration and ultimate fate of various contaminants in the different environmental media identified at the Site. This section summarizes that discussion. Tables from the RI Report, which form a basis for the evaluation, are included in Appendix D.

1.2.4.1 Potential Routes of Migration

Migration of lead and other Site substances could occur via three pathways: air, surfac ater, and/or ground water. Appendix D - Tables 27 and 28 present a list of chemical release sources and pathways of potential migration. Winds could transport soils off-site. Precipitation could route on-site materials off the paved areas and ultimately allow the migration of these substances to the West Stream via overland flow or drainage ditches. In addition, stormwater infiltration recharges the ground water system. Ground water in the unconfined aquifer migrates predominantly to the northwest providing an additional transport route for on-site materials to migrate off-site.

1.2.4.2 Contaminant Persistence

Of the principal metals present, lead and cadmium are persistent. Sulfate, chlorides, and carbonates, the site-related anions, are also persistent. The solvents detected can be separated into the trace concentrations of aromatic components at well SD and the chlorinated volatile solvents found in the vicinity of wells 11 and BR. With respect to persistence, the aromatic compounds detected (benzene, toluene, and xylene) are biodegradable under certain conditions. The chlorinated compounds that were detected include chloroform and chlorinated ethanes and ethenes which also can degrade naturally (USEPA, 1989). Although biodegradation over time can occur, the remedial alternatives developed in Sections 3 and 4 include process options which address these organic compounds.

1.2.4.3 Contaminant Migration

The migration of the organic and inorganic compounds within the various media at the Site is discussed below. A summary of potential exposure routes and exposure pathways is presented in Appendix D - Tables 29 and 30.

Air

The USEPA notice in Appendix E states that since operations ceased at the NSNJ facility, the only point source of lead to the atmosphere that remains consists of fugitive dust emissions from the open slag piles at the abandoned plant site. As part of the attainment evaluation, the State performed dispersion modeling which showed no predicted violations of the ambient lead standard from the slag pile emissions. Based on the State's evaluation and the EPA's review, the Site is currently in attainment for fugitive lead emissions, and air dispersion does not appear to be a significant means of lead transport from the Site. Sources of lead associated with the factory complex are being addressed as part of Operable Unit 2. Site soils would be a potential source of fugitive dust emissions if disturbed during remediation of Operable Unit 1. Dust control measures would be required.

Surface Water

Surface water at or in proximity to the Site consists of stormwater runoff, the West Stream, and more remotely, the East Stream. Ponded water at the factory complex is being cleaned up as part of Operable Unit 2.

Stormwater runoff transports materials from the factory complex to adjacent soils, the West stream and ground waters, as indicated by elevated lead concentrations in these media. Site topography indicates that stormwater drains both overland and through the culvert under the railroad tracks

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toward the West Stream. The East Stream is not affected by stormwater runoff due to topography and its distance from the Site.

Lead was detected in the water and sediments of the West Stream. Transport of .s lead downstream in the West Stream occurs as indicated by the lead concentrations found .th of the railroad tracks.

Lead in the water and sediments of the East Stream is localized in distribution. Transport of this lead downstream will occur, but the rate is expected to be minimal due to low flows in the East Stream south of the railroad tracks. Water and sediment samples taken from the east stream north of the railroad tracks do not demonstrate significant increases in lead concentration.

Groundwater - Unconfined Aquifer

The unconfined aquifer groundwater flow velocity ranges from 0.03 to 2 ft per day (Geraghty & Miller, 1983). This low flow tends to limit migration of constituents within the aquifer. The result is that downgradient, off-property monitoring wells comply with USEPA and New Jersey drinking water standards, as discussed below.

In the vicinity of the factory complex, lead has been detected in the shallow zone of the unconfined aquifer at concentrations ranging from 2400 to 4400 ppb, and in the deep zone of nconfined aquifer at concentrations ranging from 9 to 56 ppb. Analytical results from wells 1 ppb) and 17 (2.6 ppb) indicate that unconfined aquifer groundwater meets the NJDEPE PQL fo d of 10 ppb within 500 feet of the downgradient property line.

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For cadmium, data from wells 15 (2.1 ppb) and 17 (LT 5 ppb) indicate that USEPA MCLs are being met for this metal within 500 feet of the downgradient property line. Data from wells LD (2 ppb), 1R (3 ppb), and 2R2 (5 ppb) indicate that USEPA MCLs for cadmium in the deep zone of the unconfined aquifer are being met within the property line.

Unconfined aquifer wells 11 and BR contained concentrations of organic compounds which exceeded USEPA MCLs and New Jersey Drinking Water Standards, as described below:

Compound	Well	Conc*	NJ Std*	USEPA MCL*
1,1,1 trichloroethane	11	2500	26	200
1,1 dichloroethene	11	210	2	7
tetrachloroethene	11	210	1	5
vinyl chloride	BR	76	2	2

* Concentrations in ppb.

In addition, well SD contained chloroform at 7 ppb. Organic compounds were not detected in unconfined aquifer well MD, which is at the downgradient property boundary. 1,1,1 trichloroethane was detected in well 2R2, also at the downgradient property boundary, but at a concentration of 21 ppb, which meets the USEPA MCL and the New Jersey Drinking Water Standard. The results suggest that organic compounds have not migrated off the property, and are only of concern in the localized vicinity of wells 11, BR, and SD.

Groundwater - Confined Aquifers

Concentrations of inorganic constituents (e.g. lead, cadmium, and arsenic) in the confined aquifers beneath the Site comply with USEPA and New Jersey Drinking Water Standards. Organic constituents were not detected in the confined aquifers, with the exception of acetone in well 20 (12 ppb). There is no USEPA or New Jersey MCL for acetone. The concentration detected may be the result of contamination of sampling or analytical equipment.

1.2.5 Baseline Risk Assessment

The RI Report presented a detailed site-specific risk assessment which addresses on-site and off-site conditions and exposures to humans. It was determined that the major pathway driving current Site risks to human health is soil and that the major pathway driving future Site risks is ground water. The Risk Assessment is summarized in the following paragraph. Tables from the RI Report, which form the basis of the Risk Assessment, are included in Appendix D.

Based on the risk assessment, current exposures to arsenic, antimony, cadmium, chromium and zinc in the soils and ground water at the Site do not present carcinogenic or non-carcinogenic health effects to the children, adults, or the workers off-site. However, three different future exposure scenarios involving exposure to on-site ground water at current concentrations might pose potential health effects to the three types of individuals. Since the assumption that current on-site ground water concentrations is representative of future exposures at off-site locations does not take into account transport mechanisms (such as ground water and soil characteristics, i.e. cation exchange capacities), it is a conservative assumption which may further overestimate the potential future risks related to the ground water pathway. The carcinogenic risk and HI for a hypothetical on-site worker, assuming no site remediation, were within Superfund Site Remediation Goals (HI less than or equal to 1).

1.2.6 Applicable or Relevant and Appropriate Requirements and "To Be Considered" Information

Applicable or Relevant and Appropriate Requirements (ARARs) establish a framework for the selection of remedial alternatives at the Site. Draft guidance on the selection and use of ARARs is provided in an August 1988 publication titled <u>CERCLA Compliance with Other Laws Manual</u> (USEPA, 1988). The purpose of this section is to identify ARARs and other information "to be considered" during the evaluation of remedial alternatives at the Site, and to identify other sources of guidance or standards "to be considered" in selecting a remedy for the site.

ARARs are conveniently separated into three general types: chemical specific, action specific, and location specific.

> Chemical specific requirements"... are usually health or risk based numerical values or methodologies which, when applied to site specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment" (USEPA, 1988).

> Action specific requirements"... are usually technology or activity based requirements or limitations on actions taken with respect to hazardous wastes" (USEPA, 1988).

> Location specific requirements"... are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they occur in special locations" (USEPA, 1988).

The following are identified as potential ARARs for the Site. Detailed evaluation of these potential ARARs is presented in Section 4.

Potential Chemical Specific ARARs

Federal

- Clean Water Act, Water Quality Criteria
- RCRA Identification of Hazardous Waste (40 CFR 261)
- RCRA Ground Water Protection Standards (40 CFR Part 264.94)
- Federal Water Quality Criteria (51 Federal Register 436665)
- National Ambient Air Quality Standards (NAAQS) (40 CFR 50) for sulfur dioxide, particulate matter, carbon monoxide, ozone, nitrogen dioxide, lead.

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New Jersey

- New Jersey Regulation for Hazardous Waste Identification (NJAC 7:26-8)
- New Jersey Surface Water Standards (NJAC 7:9-4)
- New Jersey Ground Water Quality Standards (NJAC 7:9-6)
- New Jersey Ambient Air Quality Standards (NJAC 7:27-13) for suspended particulate matter, sulfur dioxide, carbon monoxide, ozone, lead, nitrogen dioxide.
- New Jersey Prohibition of Air Pollution (NJAC 7:27-5)

Potential Action Specific ARARs

Federal

- RCRA Subtitle C Closure and Post-Closure Standards (40 CFR 264, Subpart G)
- RCRA Standards for Generators of Hazardous Waste (40 CFR 262)
- RCRA Ground Water Monitoring and Protection Standards (40 CFR 264, Subpart F)
- RCRA Transporter Requirements for Manifesting Waste for Off-site Disposal (40 CFR 263)
- RCRA Transporter Requirements for Off-Site Disposal (40 CFR 263)
- RCRA Subtitle D Nonhazardous Waste Management Standards (40 CFR 257)
- RCRA Land Disposal Restrictions (40 CFR 268) (On-and off-site disposal of materials)
- Clean Water Act - NPDES Permitting Requirements for Discharge of Treatment System Effluent (40 CFR 122-125)
- DOT Rules for Hazardous Materials Transport (40 CFR 107, 171.1-171.500)
- Occupational Safety and Health Standards - Hazardous Waste Operations and Emergency Responses (29 CFR 1910.120)
- Occupational Safety and Health Standards - Construction Industry Standards (29 CFR 1926)
- USEPA Action Level for Lead in Drinking Water

New Jersey

- New Jersey RCRA Closure and Post-Closure Standards (NJAC 7:26-1 et seq.)

- New Jersey Noise Pollution Regulations (NJAC 7:29 et seq.)

- New Jersey Nonhazardous Waste Management Requirements (NJAC 7:26-2)

- New Jersey Pollutant Discharge Elimination System Regulations (NJPDES) and Effluent Limitations (NJAC 7:14A et seq.)

- New Jersey Air Pollution Control Regulations (NJAC 7:27 et seq.)

- New Jersey Soil Erosion and Sediment Control Act Requirements (NJAC 4:24-42 and NJAC 2:90-1.1 et seq.)

- New Jersey Waste Treatment Regulations (NJAC 7:1-13)

Potential Location Specific ARARs

Federal

- Fish and Wildlife Coordination Act (16 USC 661 et seq.)

- National Environmental Policy Act (42 USC 4341 et seq.)

- Natural Historic Preservation Act

- Endangered Species Act

- Coastal Zone Management Act

- Farmland Protection Policy Act

New Jersey

- New Jersey Rules on Coastal Resources and Development (7:7E-1.1 et seq.)

- New Jersey Freshwater Wetlands Regulations

"To Be Considered" Information

- Executive Order 11988 (Floodplain Management)

- Executive Order 11990 (Wetlands Protection)

- USEPA Statement of Policy on Floodplains and Wetlands Assessments for CERCLA Actions (1985)

SECTION 2

SECTION 2 - IDENTIFICATION AND SCREENING OF TECHNOLOGIES

2.1 Introduction

The identification and screening of remedial technologies was accomplished using a multi-phased approach based on USEPA's Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (Interim Final, October 1988a). The approach used was consistent with the Administrative Order on Consent Docket No. CERCLA-60109 entered into by NL Industries and EPA and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP, 40 CFR Part 300). This section describes the key elements used in the approach.

Remedial Action Objectives are medium-specific or operable unit-specific goals for protecting human health and the environment. Remedial action objectives are formed based on the site-specific risk assessment and potential ARARs. Remedial action objectives (sometimes herein referred to as response or remedial objectives) for the Site are developed in Section 2.2.

General Response Actions address and satisfy specific remedial action objectives. The general response actions for the Site are identified in Section 2.3.

Remedial Technologies are utilized to implement general response actions. Remedial technologies considered potentially applicable to the Site are identified and screened in Section 2.4.

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Process Options are specific processes and variations within a remedial technology which could be utilized alone or in conjunction with other process options to implement a general response action. Process options considered potentially applicable to the Site are identified and screened in Section 2.4.

The approach used in developing remedial alternatives is first to define remedial action objectives based on the risk assessment and potential ARARs. Next, general response actions are identified which address these remedial action objectives. Potentially applicable remedial technologies and process options are then screened for effectiveness, implementability, and cost. The objective is to produce a finite set of process options which are technically and economically feasible and effective. Finally, selected process options, chosen to implement respective general response actions, are combined to form remedial alternatives.

2.2 Remedial Action Objectives

For this Feasibility Study, the identified media of interest are soil, ground water and sediments. Remedial action objectives have been identified for these media as follows:

Soil

Establishing a remedial action objective for soil requires addressing each of the potential exposure route/receptor combinations and must take into consideration the following:

- Human Health;
- Biota; and
- Protection of Ground Water.

A human health risk assessment, which was presented in the approved RI Report and subsequent USEPA Addendum, addressed potential risks to human receptors. Potential risks to biota were evaluated in the Draft Ecological Risk Assessment developed by the EPA (January 1993). Both of these documents were utilized in the evaluation of remedial alternatives.

For each of the potential exposure route/receptor combinations, a concentration or range of concentrations will be identified which is considered to be sufficiently protective. The remedial action objective(s) selected for use during the Feasibility Study will be the concentration or concentration range which is identified as protective for the most sensitive exposure route/ receptor combination.

The approved RI Report and subsequent USEPA Addendum included an evaluation of human health exposure scenarios and risk calculations. Tables presented in Appendix D summarize available information and calculations used to evaluate the risk to human health from soil ingestion. The results indicated that ingestion of soil at existing concentrations did not pose an unacceptable risk for arsenic, antimony, cadmium, chromium, and zinc based on USEPA methodologies. The exposure scenario used was for industrial use of the property, an appropriate and likely future land use, since the property is zoned industrial, is likely to be the location of long-term ground water recovery and treatment facilities, and is the site of a closed RCRA landfill.

Since a reference dose is not currently available for lead, a USEPA published Directive-(#9355.4-02, September 1, 1989) which states that remediation of soil to 500 to 1000 ppm of lead in residential soil is protective of human health, was used. This document was based on a study which stated that

"In general, lead on soil and dust appears to be responsible for blood lead levels in children increasing above background levels when the concentration in soil or dust exceeds 500-1000 ppm."

The presence of soluble lead in the ground water beneath portions of the Site raises the question as to whether surface soil lead is migrating to ground water. Lead in ground water can be attributed to two pathways: migration of battery acid and other liquids containing lead from the manufacturing area, and leaching from soil by rain water. Historic information indicates that the former contributed to elevated ground water concentrations of lead. This section focuses on the latter.

The USEPA and PEI Associates demonstrated that a Site soil sample with a lead concentration of 57,150 ppm diluted 10:1 with tap water and agitated for 30 minutes resulted in a water lead concentration of 79 ppb (USEPA 1989). This relatively low release rate was supported by USEPA's contractor, Ebasco Services, who conducted TCLP testing on stream sediments from location EPA 2. The results presented in Appendix A indicate that for a sediment lead of 1340 ppm the leachable lead under mildly acidic conditions was 134 ppb. Utilizing the USEPA methodology for selecting characteristics of a hazardous waste (100:1 attenuation factor) and the current New Jersey Ground Water Standard of 10 ppb lead, leaching of lead from soil at concentrations as high as 10,000 ppm could be protective.

The protection of biota was the topic of the Ecological Assessment. Appendix F presents a summary of the toxicity evaluation of the Ecological Assessment. The results suggest that protection of flora, as well as vertebrates and invertebrates, can be achieved at soil lead concentrations in the range of 500 - 1000 ppm.

In summary, the concentrations of lead in soil which is considered to be protective of human health and biota in residential areas ranges from 500 to 1,000 ppm for direct contact with the soil. Lead concentrations of 10,000 to 15,000 ppm are considered to be protective of human health and biota with respect to leaching of lead from surface soils. Pursuant to USEPA's request of November 4, 1991, the remedial action objective for surface soils will be in the range of 500 to 1000 ppm. In accordance with USEPA's direction, each alternative will be evaluated for a 500 ppm objective and a 1000 ppm objective. Because the property is zoned industrial, includes a RCRA landfill, and will likely include a wastewater treatment plant, residential use of the property is not anticipated.

Ground Water

As ground water has been identified as the primary pathway for future exposures in the risk assessment, the remedial action objective is to achieve the USEPA and New Jersey Maximum Contaminant Levels (MCLs) for the identified site-related substances. Table 5 presents these substances and their corresponding MCLs. The action level for the principal metal of concern at the Site, lead, is 15 ppb; the NJDEPE ground water quality criteria Practical Quantitation Limit (PQL) for lead is 10 ppb. The remedial action objective for lead in ground water will therefore be 10 ppb. The remedial action objective for 1,1,1 trichloroethane, 1,1 dichloroethene, and tetrachloroethane detected in well 11 will be the New Jersey Ground Water Standards of 26, 2, and 1 ppb, respectively. The remedial objective for the vinyl chloride detected in well BR will be 2 ppb based on New Jersey Ground Water Standards.

Sediment

A biota study has been conducted by USEPA to evaluate the impact of lead on aquatic and benthic organisms. Based on that study, the USEPA has developed sediment criteria for the site of 500 to

1,000 ppm. However, a discussion of surface water quality at the site is essential in evaluating the range and extent of sediment remediation required. For this reason, the following discussion of surface water is provided.

Ambient Water Quality Criteria were proposed by the USEPA (1986) to protect freshwater aquatic organisms. The ambient water quality criterion (AWQC) for lead is a function of the hardness of the receiving water (expressed in mg/l as $CaCO_3$).

The measured hardness of surface waters in the East and West Stream range from 55 to 280 mg/l as $CaCO_3$. The following chart illustrates a typical range of AWQC for lead in the East and West Streams.

Hardness (mg/l as $CaCO_3$)	ACUTE AWQC (ppb lead)	CHRONIC AWQC (ppb lead)
50	34	1.3
100	82	3.2
200	200	7.7

Figure 19 illustrates the ratio of the 1990 total lead concentration of surface water to the AWQC - acute and chronic. A value greater than 1 means that the relevant AWQC is exceeded in that portion of the water column. The West Stream south of Route 130 contains lead in excess of the AWQC - acute. This is also true along a segment of the East Stream immediately south of the railroad tracks. The AWQC - chronic was exceeded principally in the area upstream of the confluence of the East and West Streams, north of U.S. Route 130. The exceedances in the immediate vicinity of the site south of U.S. Route 130 ranged from 14 to 140 times AWQC-chronic suggesting that lead from these segments is affecting water quality north of U.S. Route 130. It should be noted that AWQC - chronic for lead is exceeded in two tributaries that are not affected by runoff from the Site, but which discharge into the streams north of U.S. Route 130 (i.e., sample locations EPA-1 and EPA-6). Thus, it is possible that some upstream source that affects the water quality in these tributaries also affects water quality north of U.S. Route 130.

South of U.S. Route 130, sections of the East and West Streams are seasonally intermittent and have extremely low flow. The physical dimensions of the streams are illustrated in the photographs in Appendix C. In contrast, north of U.S. Route 130, after the streams merge, the combined width exceeds thirty feet, and the flow increases dramatically as other tributaries feed into the stream.

Because of their relatively low flow, the portions of the East and West Streams south of U.S. Route 130 are readily amenable to dewatering or redirection. This makes it possible to excavate with precision in three dimensions, and to minimize the possibility of sediment slump and resuspension of lead-bearing sediments. Excavation of the stream segments north of U.S. Route 130 would be detrimental to the aquatic environment. These stream segments are too large to be diverted or dewatered, and thus remediation would have to consist of dredging in a water column. Such dredging will likely result in downstream transport of entrained, lead-bearing sediments. Sediment resuspension during the dredging will likely also increase the concentration of lead in the water column. Consequently, dredging these stream sediments would be destructive to the existing ecosystem, increasing turbidity and adversely impacting existing benthic flora and fauna.

These risks are illustrated by the preliminary results of field work performed by Dr. Mark Sprenger, using sediments collected from the site. Dr. Sprenger's draft report concluded that:

"Any sediment removal efforts should consider that disturbances of sediment could lower pH and potentially make lead in other areas of the streams more available for uptake, regardless of concentration." (Draft Ecological Risk Assessment, USEPA, January 1993)

The remedial action objecti ɔr lead in sediments is to remediate sections of the East and West Streams, south of U.S. Route 130, as illustrated on Figure 32 and north of U.S. Route 130 as illustrated on Figures 32.1 and 32.2. It is anticipated that the water quality of these downstream segments will improve as remedial work at the Site progresses for several reasons. First, removal of the upstream sediments where higher levels of lead are currently found will remove the source of the downstream exceedances of ambient water quality criteria. Moreover, as work at the Site progresses on the Operable Unit 2, such as the removal of lead-bearing slag, waste piles and pooled surface water, other sources now contributing to the presence of lead downstream will be eliminated.

2.3 Media Volumes and General Response Actions

2.3.1 Media Volumes

Based on the remedial action objectives identified in Section 2.2, estimated volumes of each media have been defined.

Soil

Estimated volumes of soil have been defined for the remedial action objectives of 500 ppm and 1000 ppm. Figures 23 and 24 display the area and depth of lead concentrations ›ve these objectives based on the data presented on Table 1.

Response Objective (ppm lead in soil)	In-Situ Volume (cu. yd.)
1000	21,000
500	29,800

Ground Water

Table 2 summarizes ground water quality at the Site. The unconfined aquifer exceeds ground water standards for a number of constituents, but primarily lead and cadmium. Figures 33 and 34 illustrate ground water quality for lead and cadmium, respectively, in the shallow portion of the unconfined aquifer. Figures 35 and 36 illustrate ground water quality for lead and cadmium, respectively, in the deeper portion of the unconfined aquifer. Organic compounds were detected in excess of ground water standards in monitoring wells 11 and BR which monitor the deeper portion of the unconfined aquifer. The confined aquifers meet ground water standards for the parameters analyzed.

Sediments South of U.S. Route 130

The volumes of sediment proposed to be excavated from the east and west streams south of U.S. Route 130 are based on total lead concentrations of 500 ppm and 1,000 ppm. Where TCLP lead and EP Toxicity lead data was not available, it was assumed that samples exhibiting total lead concentrations in excess of 2,000 ppm would require treatment. Samples with total lead concentrations below 2,000 ppm would not require treatment.

Based upon these calculations, the proposed excavation of sediments would account for a total volume of 900 CY at a 1,000 ppm total lead limit or 1,500 CY at a 500 ppm total lead limit, south of U.S. Route 130.

Sediments North of U.S. Route 130

Complete information is unavailable as to whether remediation of the sediments north of U.S. Route 130 would be beneficial to human health or the environment. The risk assessment and the USEPA's Draft Ecological Risk Assessment did not address this media directly. Additionally, the USEPA Directive regarding lead remediations would not be applicable since the subject area is not residential.

The stream systems north of U.S. Route 130 are radically different from the systems in the vicinity of the site. These differences consist of both physical location and potential contributors of contaminants; and, ecological make-up. The East and West Streams have the potential for direct impact from the site through surface runoff or air deposition. Streams north of U.S. Route 130, however, can receive impact from tributaries that d[illegible] into it (of which the East and West Streams are or[illegible] two of four) as well as from direct runoff of the Corps of Engineers dredge spoils piles. Remediation of the streams south of U.S. [illegible]ute 130 would [illegible]move only one potential source of lead in the northern channels. Additionally, [illegible] to the size and complexity of the stream systems, the risks associated with the remediation, as highlighted in the USEPA Draft Ecological Risk Assessment (January 1993), should be tantamount in decisions concerning remedial actions north of U.S. Route 130. When this is coupled with the possibility of recontamination from other sources not related to the Site (i.e. dredge spoils piles and other tributaries) remediation of the stream sediments north of U.S. Route 130 is not justifiable. Howev[illegible] based on direction received by the USEPA, remedial alternatives will be evaluated.

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In evaluating remedial alternatives, the volumes of sediment proposed to be excavated from the Corps of Engineers streams north of U.S. Route 130 are based on total lead concentrations of 500 ppm and 1,000 ppm. Where TCLP lead and EP Toxicity lead data was not available, it was assumed that samples exhibiting total lead concentrations in excess of 2,000 ppm would require treatment. Samples with total lead concentrations below 2,000 ppm would not require treatment.

Based on these calculations, it is proposed to excavate a total volume of 3,750 CY of sediments (1,000 ppm total lead limit) or 7,500 CY of sediments (500 ppm total lead limit) North of U.S. Route 130.

2.3.2 General Response Actions

General response actions address remedial action objectives. The general response actions which are applicable to the Site can be categorized as institutional actions, containment actions, removal actions, and treatment actions. In addition, no action is also considered in accordance with USEPA guidance (USEPA, 1988a). A brief description of each general response action follows.

No Action: This general response action does not contain technologies but rather can be used to track Site conditions in the absence of remediation. No Action is typically carried through the Feasibility Study as an alternative which is used as a basis for comparing the other alternatives.

Institutional Actions: Institutional Actions include local, State, and Federal restrictions which can be enacted and enforced to protect public health and the environment in the vicinity of the Site before, during, and/or after implementation of remedial action. Site access restrictions,

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such as fencing, and Site use restrictions, such as deed restrictions, are also considered institutional actions.

Containment Actions(Disposal): Containment Actions include technologies which isolate materials from migration pathways or receptors such that exposure pathways are not complete. Containment actions are also utilized to provide the ultimate disposition of contaminated/treated media.

Removal Actions: Removal Actions include technologies which prevent complete exposure scenarios by removing source materials.

Treatment Actions: Treatment Actions address contaminants by reducing their toxicity, mobility, or volume.

2.4 Identification and Screening of Remedial Technologies and Process Options

2.4.1 Soil

The screening of technologies for soil is presented in depth in Appendix G and is summarized below:

SOIL REMEDIAL TECHNOLOGIES

General Response Objective	Remedial Technology	Process Option	Screening
Institutional	Access Restrictions	Fencing	Retained
		Deed Restrictions	Retained
	Monitoring		Retained
Containment (Disposal)	Cover	Soil/Vegetative	Rejected
	Cap	Multi-Media	Retained
	Landfill	On-Site	Rejected
		Off-Site	Retained

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General Response Objective	Remedial Technology	Process Option	Screening
Treatment	Solvent Extraction	Soil Washing	Retained
		Hydro-Metallurgical Leaching	Rejected
		Electromembrane Reactor Leaching	Rejected
		Acid Leaching	Rejected
	Solidification/Stabilization	Portland Cement	Retained
		Solidtech Process	Retained
		Chemifix Process	Retained
		Hazcon Process	Retained
		Asphalt Emulsion	Rejected
	Tilling	Tilling	Rejected
	Thermal Treatment	Flame Reactor	Rejected
		Electrokinetics	Rejected
		Vitrification	Rejected
		Plasma Reactor	Rejected
		Cyclone Furnace Process	Rejected
Removal	Excavation	Standard Construction Procedures	Retained

Institutional controls such as access restrictions and monitoring were retained as effective components of any remedial alternative.

A multi-media cap was retained as a containment technology that would be effective in preventing direct contact with lead containing soils by both humans and biota. The multi-media cap would provide additional protection to burrowing animals via the installation of a gravel drainage layer which would discourage burrowing. The multi-media cap and liner system will signficantly reduce the potential for rainwater leaching of contaminants from the soil.

An off-site landfill was retained to provide an off-site alternative.

Two treatment based technologies were retained for further evaluation: solidification/stabilization and soil washing. These technologies are being retained for development as alternatives since a portion of the site soils have been identified as a characteristically hazardous waste.

2.4.2 Ground Water

The screening of technologies for ground water is presented in depth in Appendix H and is summarized below:

GROUND WATER REMEDIAL TECHNOLOGIES

General Response Objective	Remedial Technology	Process Option	Screening
Institutional	Access Restrictions	Deed Restrictions	Retained
	Monitoring	Ground Water	Retained
Containment	Subsurface Barrier	Slurry Wall	Rejected
		Grout Curtain	Rejected
	Recovery Wells	Well Points	Retained
		Submersible Pumps	Retained
Treatment	Precipitation/Flocculation	Hydroxide	Retained
		Sulfide	Retained
		Carbonate	Retained
		Sodium Borohydride	Retained
		Iron Coprecip.	Retained
		Ferrihydrate	Retained
	Activated Alumina Abs.		Rejected
	Evaporation		Rejected
	Ion Exchange		Retained
	Ion Medial Filtration		Rejected
	Reverse Osmosis		Retained
	Hyper/Ultrafiltration		Rejected
	AlgaSORB®		Rejected
	Wetlands-Based		Rejected
	Discharge	Infiltration Pond	Retained
		Unconfined Aquifer	Retained
		Leach Field	Retained
		Infiltration Trenches	Retained
		Reinjection Wells	Retained
		East Stream	Retained
		West Stream	Retained
		Delaware River	Retained
		Confined Aquifer	Retained

Institutional controls such as access restrictions and monitoring were retained as effective components of any remedial alternative.

Subsurface barriers were rejected on the basis of effectiveness. The clay lensing in the unconfined aquifer and the variable depth of 20 to 70 feet of the confining layer will make construction and control difficult.

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Precipitation/Flocculation was retained as a ground water treatment technology. Additional bench scale testing will be required to select the optimum combination of precipitants and flocculents. The other treatment technologies were rejected on the basis of technical implementability. Most require extensive pretreatment. These technologies may, however, be utilized to polish ground water treated by precipitation/flocculation, should bench scale testing show that polishing is required.

The discharge technologies retained included: direct discharge to the East or West Stream and subsurface discharge to the unconfined aquifer via an infiltration pond, leach field, infiltration trenches and reinjection wells. Discharge to the Delaware River was rejected on the basis of cost. Discharge to a confined aquifer was also retained based upon possible deep well injection.

Recovery of ground water using the installed well point system and using submersible pumps were both retained for further evaluation.

2.4.3 Sediment South of U.S. Route 130

The screening of technologies for sediment remediation is presented in depth in Appendix I-1 and is summarized below:

SEDIMENT REMEDIAL TECHNOLOGIES

General Response Objective	Remedial Technology	Process Option	Screening
Institutional	Access Restrictions	Fencing	Rejected
Containment	Stream Diversion	Channel	Retained
		Pipe	Rejected
		Hydraulic	Rejected
Treatment	Dewatering	Confined Disposal Facility (CDF)	Rejected
		Mechanical	Rejected
		Portland Cement	Retained
Removal	Mechanical Dredging	Clamshell/Orangepeel	Rejected
		Dragline	Rejected
		Backhoe	Retained
		Backhoe w/ Access Stabilization	Retained
		Bucket Ladder	Rejected

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Hydraulic Dredging	Cutterhead	Rejected
	Dustpan	Rejected
	Horizontal Auger	Rejected
	Matchbox	Rejected
	Pneuma	Rejected

Due to the narrow width, low flow rate and termittent nature much of the surface water in the areas to be remediated, traditional technologies (e.g., hydraulic dredging with dewatering using a confined disposal facility) were not applicable. Process options that were retained include backhoe excavation with dewatering as required.

2.4.4 Sediment North of U.S. Route 130

The screening of technologies for sediment remediation is presented in depth in Appendix I-2 and is summarized below:

SEDIMENT REMEDIAL TECHNOLOGIES

General Response Objective	Remedial Technology	Process Option	Screening
Institutional	Access Restrictions	Institutional Controls	Rejected
Containment	Stream Diversion	Channel	Rejected
		Pipe	Rejected
		Hydraulic	Rejected
Treatment	Dewatering	Confined Disposal Facility (CDF)	Rejected
		Mechanical	Retained
		Portland Cement	Retained
Removal	Mechanical Dredging	Clamshell/Orangepeel	Retained
		Dragline	Rejected
		Backhoe	Rejected
		Bucket Ladder	Rejected
	Hydraulic Dredging	Cutterhead	Rejected
		Dustpan	Rejected
		Horizontal Auger	Rejected
		Matchbox	Rejected
		Pneuma	Rejected

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SECTION 3

SECTION 3 - DEVELOPMENT AND SCREENING OF ALTERNATIVES

3.1 Introduction

This section sets forth, and screens remedial alternatives for use at the NL Industries, Inc. Site. In order to simplify evaluation, each alternative is presented as a media-specific action.

3.2 Soil Alternatives

Twenty-two soil alternatives were considered for use at the NL Industries, Inc. Site. Appendix G discusses each of these in detail. Of the 22 alternatives, the following were retained for further consideration:

Soil A-	No Action/Institutional Controls
Soil B-	Excavation of All Soils above Action Level/Soil Washing of All Excavated Soil/Return Treated Soils to Site/Disposal
Soil C-	Excavation of All Soils Above Action Level/Solidification/ Stabilization (S/S) of All Excavated Soil/Consolidation On-Site
Soil D-	Excavation of All Soils Above Action Level/Soil Washing of Hazardous Soils Requiring Treatment/Consolidation On-Site/Disposal
Soil E-	Excavation of All Soils Above Active Level/On-Site S/S of Hazardous Soils Requiring Treatment/Off-Site Disposal
Soil F-	Excavation of All Soils Above Action Level/On-Site S/S of Hazardous Soils/Consolidation On-Site
Soil G-	Excavation of All Soils Above Action Level/Off-Site Disposal
Soil H-	Excavation of On-Site Soils Over 1,000 ppm Lead and Off-Site and Wetland Soils Over 500 ppm Lead/On-site Consolidation/Disposal

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At the direction of the USEPA, this Feasibility Study considers 2 response objectives: 500 ppm and 1,000 ppm. The insitu volumes of soil exceeding each of these response objectives are estimated at 21,000 and 29,800 cubic yards, respectively. Assuming a 10% expansion factor upon excavation, approximately 23,100 and 32,800 cubic yards of soil would be remediated at the 1,000 and 500 ppm cleanup levels, respectively. However, it is justifiable based on the Site Ecological Assessment conducted by the USEPA, and the USEPA directive concerning lead remediations, to evaluate a remedial scenario consisting of an on-site action level of 1,000 ppm, and an off-site and wetlands action level of 500 ppm. To illustrate this scenario, Alternative H has been developed. This alternative represents excavation of approximately 27,500 cubic yards (30,250 with 10% expansion).

For Soil Alternatives D, E, F, G and H, soil volumes are divided into hazardous soils which are land disposable, hazardous soils requiring treatment and non-hazardous portions. Hazardous soils requiring treatment are those excavated soils which are assumed to fail both the TCLP and EP Toxicity tests. Current land disposal regulations require that soils meeting these characteristics be treated to pre-approved levels prior to disposal in a hazardous waste landfill. Hazardous soils which are land disposable are those excavated soils which are assumed to fail TCLP but pass EP Toxicity. Such soils are still considered a hazardous waste but can be disposed of at a hazardous waste landfill without pre-treatment (Land Disposal Restrictions, 55 CFR 106). Non-hazardous soils are those excavated soils which are assumed to pass both the TCLP and EP Toxicity tests. The evaluation of soil alternatives relies heavily on the amount of material that is assumed to be hazardous and require treatment. As directed by the USEPA, soils associated with lead contamination exceeding 2,[illegible] ppm are assumed to fail TCLP. This corresponds to a volume of approximately 10,[illegible] cubic yards of soil after excavation which will be considered hazardous. Soil samples collected by O'Brien & Gere Engineers in February 1993 were subjected to TCLP and EP Toxicity. The results of this analysis indicate that of the 10,000 cubic yards to be considered hazardous, 5,000 cubic yards can be assumed to pass the EP Toxicity test and be land disposable at a hazardous waste landfill without treatment. Thus, 5,000 cubic yards of excavated soil will require pre-treatment prior to land disposal. Additional sampling during the remedial design phase will be required to confirm these estimates.

All soil alternatives, with the exception of the no action alternative, involve excavating contaminated soils. Following excavation of soils, post-excavation sampling will be performed to evaluate whether additional soils need to be removed to achieve the 500 ppm lead or 1,000 ppm lead response actions. The ultimate disposal of non-hazardous soils at an on-site consolidation area or an off-site disposal facility is dependent on several factors, including the selected cleanup level for soils, the amount of material requiring disposal (non-hazardous and treated soils), the limited area available for on-site consolidation, and any wetlands which may be impacted by the remedy.

Fugitive dust control will be a high priority during remedial action because of the presence of lead in the soils. The remedial design will include methods for control of fugitive dust emissions from treatment activities including: excavation, soils staging, treatment, and transportation, if necessary. The remedial design will also include dispersion modelling using estimated potential emission rates to evaluate whether the National Ambient Air Quality Standard for lead can be achieved with or without control.

All soil alternatives will be carried out in conjunction with a ground water program which will consist of ground water monitoring and possible pumping and treating of ground water. Potential leaching of lead into ground water will thus be addressed through the selected ground water remediation alternative.

3.2.1 Soil Alternative A - No Action/Institutional Controls

Under Soil Alternative A, institutional controls will be applied to the Site in those areas w soil do not meet response objectives. These institutional actions will include site access restricti e.g., fencing and deed restrictions).

3.2.2 Soil Alternative B - Excavation of All Soils Above Action Level/Soil Was of All Excavated Soil/Return Treated Soils to Site/Disposal

For the purpose of developing Soil Alternative B, it is assumed that all excavated soils will be treated. This corresponds to a volume of 23,100 cubic yards for the 1,000 ppm response objective and 32,800 cubic yards for the 500 ppm response objective. This alternative evaluates soil washing as eatment technology. Due to the relatively inconsistent results ac ed with soil washing on lead contaminated solids to date, the remedial design will include a bench scale treatability program to evaluate the effectiveness of various chemical washing agents on the lead containing soils at the Site as well as an on-site pilot demonstration to assess the materials handling requirements and overall effectiveness of soil washing under site specific conditions.

In order to implement this alternative, excavated soil will be screened to remove oversized debris and then mixed with water to form a slurry. The slurry will be transferred to a reactor where it will be subjected to washing agents to remove the lead from the soil. Washed soil will be filtered to remove excess water. This water will be collected and transported by tanker trucks to the nearby Dupont wastewater disposal facility in Deepwater, NJ or another appropriate facility for disposal.

The dewatered soil meeting the 500 ppm or 1,000 ppm response objective will be tested for hazardous characteristics and non-hazardous soil will be backfilled into the initial excavation area. It is assumed that the soil washing treatment technology will have a treatment efficiency of 70%. As described in Section 4.2.2.6, it is highly unlikely that this efficiency will be achieved at the Site especially for soils with lead concentrations below 1,000 ppm. Dewatered soils not meeting response requirements will be solidified/stabilized and disposed of as described in Alternative C. It is estimated that 9,000 cubic yards of material will require further solidification after soil washing. The solidification/stabilization process significantly limits the leaching potential of treated soils. Therefore, stabilized soils may be placed in the on-site consolidation area or at an off-site disposal facility. In costing this remedy it has been preliminarily assumed that stabilized soils will be disposed off-site.

The soil washing treatment system will be placed on-site in the vicinity of the existing plant facility (which will first be demolished under OU-2). This area is an ideal location for a treatment system due to its proximity to the soils to be excavated and because utilities (power, water) are readily procured. Figure 25 shows the location of the system. Areas of excavation (and of subsequent backfill with non-hazardous, washed soil meeting the response objectives) are shown on Figures 23 and 24.

<u>3.2.3 Soil Alternative C - Excavation of All Soils Above Action Level/Off-Site Solidification/Stabilization (S/S) of All Excavated Soil/Consolidation On-Site</u>

For the purpose of developing Soil Alternative C, it is assumed that all excavated soils will be treated. This corresponds to a volume of 23,100 cubic yards for the 1,000 ppm response objective and 32,800 cubic yards for the 500 ppm response objective. This alternative evaluates solidification/stabilization as a treatment technology. The remedial design will include a bench scale treatability program to evaluate the effectiveness of various binding agents on solidifying and stabilizing the Site soils. Treatment of excavated soils by S/S will result in a volume increase of approximately 50% based on previous experience (USEPA Site Demonstration of Chemfix Process, 1987 by Edwin F. Barth and Evaluation of S/S for Treatment of Contaminated Soils from Waldick Aerospace Services - prepared August 1991 by U.S. Army Waterways Experiment Station for U.S. Army Corps of Engineers). For this alternative it is assumed that solidification/stabilization will take place on-site with subsequent consolidation on-site.

The hazardous fraction of excavated soils will be blended with binding and stabilizing agents and then staged to allow the soil to cure. Upon curing, the stabilized/solidified soil will be subjected to TCLP to confirm that the treated batch meets land disposal restrictions. Soils meeting TCLP land disposal requirements will be consolidated on-site. Figure 26 shows the location of the treatment and soil staging areas in the vicinity of the existing plant facility which will be demolished as part of OU-2. This area is ideal for a soil staging area due to its proximity to the excavation areas and access for trucks.

3.2.4 Soil Alternative D - Excavation of All Soils Above Action Level/Soil Washing of Hazardous Soils Requiring Treatment/Consolidation On-Site/Disposal

For the purposes of developing Soil alternative D, it is assumed that only hazardous soils which require treatment will be selected for soil washing. It is estimated that approximately 21,000 cubic yards and 29,800 cubic yards of material will be excavated under this alternative corresponding to the 1,000 and 500 ppm response objectives. This alternative is based on the assumption that the majority of excavated soils will not require treatment. Upon examination of unit costs of on-site soil washing in comparison to off-site transportation and disposal of hazardous soil, it was decided that off-site transportation and disposal of hazardous soil which passes EP Toxicity was more economically advantageous than on-site soil washing. Therefore, under Soil Alternative D, non-hazardous soil not meeting the response objectives will be excavated, consolidated, and capped on-site. Soils which fail both TCLP and EP Toxicity will be treated via soil washing as described in Soil Alternative B and consolidated on-site with the excavated non-hazardous soils. Soils which fail TCLP but pass EP Toxicity will be transported via truck or rail to a hazardous waste land disposal facility for disposal.

The excavated non-hazardous soil will be placed on-site in a consolidated area, east of the existing landfill as indicated on Figure 28. Preliminary calculations suggest that this area can accommodate the assumed volume of soil to be excavated. In addition, the selected area minimizes impacts to surrounding wetlands and is adjacent to the existing RCRA landfill which will allow for ease of maintenance. The consolidated soil will be graded and a geomembrane cover will be placed over it. The geomembrane cover will consist of a 40 mil very low density polyethylene (VLDPE) membrane, a 6 inch gravel drainage layer, 24 inches of root zone soil, and six inches of topsoil followed by seed, fertilizer, and mulch. As a contingency measure, a liner will be constructed under the soil consolidation area to further minimize the potential for leachate from the area to migrate into ground water. The area will be reseeded with prairie type grasses so as to limit reforestation. Although regular maintenance of the vegetative surface will be required, the combination of soil and geomembrane has proven to be a durable combination at sites with similar characteristics.

The consolidation area will be raised above the 100-year flood plain using engineering controls to limit the potential for flooding and damage to the cap. Backfill will be brought on-site to provide a base upon which the cap can be constructed. Sufficient quantities of clean fill will be imported to raise the area above the 100-year flood plain.

Non-wetland portions of the Site outside the fenced landfill will be graded and seeded while excavated wetland portions will be restored. Topsoil will be brought to the Site as necessary to establish vegetation and to assist in grading. Areas to be excavated to meet the 1000 ppm and 500 ppm response objectives generally radiate outward from the existing building. These areas have been identified based on soil sampling and are presented in Figures 23 and 24, respectively.

<u>3.2.5 Soil Alternative E - Excavation of All Soils Above Action Level/On-Site S/S of Hazardous Soils Requiring Treatment/Off-Site Disposal</u>

For the purpose of developing Soil Alternative E, it is assumed that only hazardous soils requiring treatment will be subjected to S/S. It is estimated that approximately 21,000 cubic yards and 29,800 cubic yards of material will be excavated under this alternative corresponding to the 1,000 ppm and 500 ppm response objectives. This alternative is based on the assumption that the majority of excavated soils will not require treatment. Under this alternative, non-hazardous excavated soils will be consolidated on-site. Hazardous soils which are land disposable (fail TCLP and pass EP Toxicity) will be transported off-site to a hazardous waste landfill. Hazardous soils which require treatment (fail TCLP and fail Toxicity) will be treated via on-site solidification/stabilization (as described in Soil Alternative C), and transported off-site for disposal. Figure 27 shows the location of the treatment and curing areas in the vicinity of the existing plant facility which will be demolished as part of OU-2. This area is ideal for a treatment system due to its proximity to the excavation areas and the availability of utilities (power, water).

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3.2.6 Soil Alternative F - Excavation of All Soils Above Action Level/On-Site S/S of Hazardous Soils/Consolidation On-Site

For the purpose of developing Soil Alternative F, it is assumed that only hazardous soils requiring treatment will be subjected to S/S. It is estimated that approximately 21,000 cubic yards and 29,800 cubic yards of material will be excavated under this alternative corresponding to the 1,000 ppm and 500 ppm response objectives. This alternative is based on the assumption that the majority of excavated soils will not require treatment. Upon examination of unit costs of on-site S/S treatment in comparison to off-site transportation and disposal of hazardous soil it was decided that on-site treatment of all hazardous soil (regardless of whether or not soil passed EP Toxicity) was more economically advantageous then off-site transport and disposal. Therefore under Soil Alternative F, non-hazardous excavated soil will be consolidated on-site while all soils which are considered hazardous (fail TCLP) will be treated via on-site solidification/stabilization (as described in Soil Alternative C), and subsequently consolidated on-site along with excavated non-hazardous soils.

The on-site Consolidation Area will be as described in Soil Alternative D. Figure 27 shows the location of the treatment and curing areas in the vicinity of the existing plant facility which will be demolished as part of OU-2. This area is ideal for a treatment system due to its proximity to the excavation areas and the availability of utilities (power, water).

3.2.7 Soil Alternatives G - Excavation of All Soils Above Action Level/Off-Site Disposal

Under Soil Alternative G, all soil not meeting response objectives will be excavated and disposed of off-site. Non-hazardous soil will be transported via rail or truck to an approved off-site landfill. Hazardous soil which passes EP Toxicity will be transported via rail or truck to an approved off-site hazardous waste landfill for direct disposal. Hazardous soil which fails EP Toxicity will be transported via rail or truck to an approved off-site facility for S/S and subsequent land disposal. Non-wetland portions of the Site will be graded and seeded while wetland portions of the Site will be restored. Topsoil will be brought to the Site as necessary to establish vegetation and to assist in grading.

3.2.8 Soil Alternative H - Excavation of On-Site Soils Over 1,000 ppm Lead and Off-Site and Wetland Soils Over 500 ppm Lead/On-Site Consolidation/Disposal: Under Soil Alternative H soil not meeting specific response objectives for soils on-site (1,000 ppm lead), wetland soils (500 ppm lead) and off-site soils (500 ppm lead) will be excavated. Non-hazardous on-site soil will be consolidated on site. Excavated hazardous on-site soils which are land disposal will be transported off-site for disposal at a hazardous waste landfill. Hazardous on-site soils which requires treatment will be treated on-site via soil washing or S/S. Excavated off-site soils and wetland soils with lead concentrations over 1,000 ppm will be managed along with on-site excavated soils. Excavated off-site and wetland soils with less than 1,000 ppm will be transported on-site for use as fill. Topsoil will be brought to the site as necessary to establish vegetation, assist in grading, and control runoff and sedimentation into wetland soils.

3.3 Ground Water Alternatives

The response objective for ground water at the Site is to meet New Jersey and USEPA MCLs and USEPA action levels. This objective may necessitate pumping and treating the unconfined aquifer. The existing well point system should be effective in achieving the desired recovery. This will be confirmed during the remedial design. As described below, the required level of treatment is dictated by the location and type of discharge. Effluent for subsurface discharge will be in compliance with the established practical quantitative limit (PQL) of 10 ppb lead.

A surface discharge effluent will require in-stream concentrations consistent with Ambient Water Quality Criteria (AWQC). The AWQC for metals is a function of the hardness of the water. The higher the hardness, the higher the acceptable metal concentration. For purposes of evaluating the surface water discharge alternative, it is assumed that treatment will be necessary to achieve an effluent limitation of 7 ppb, the mean of the expected hardness based criteria of 2 ppb to 12 ppb for discharge to the East or West streams. In addition, it has been further assumed that treatment (reverse osmosis) will be required to achieve discharge limits on the total dissolved solids (TDS). Since the applicable effluent limitation is a function of the hardness of the receiving water, it will vary depending on the actual location of the discharge. Thus, a theoretical effluent limitation has been assumed herein, with the actual limitation to be determined during the remedial design phase when the actual location is defined. For discharge to the Delaware River, an effluent treatment limit of 10 ppb would be required to meet the worst case chronic discharge criteria proposed by the Delaware River Basin Commission for lead assuming a dilution factor of 6 for an outfall depth of 10 feet.

Twenty-eight process options were considered for use in remediating ground water at the NL Industries, Inc. Site. Appendix H discusses these options in detail. The following alternatives are retained for further consideration:

Ground Water A -	No Action
Ground Water B -	Pump and Treat with Subsurface Discharge via Infiltration Pond
Ground Water C -	Pump and Treat with Subsurface Discharge via Leach Field
Ground Water D -	Pump and Treat with Subsurface Discharge via Infiltration Trenches
Ground Water E -	Pump and Treat with Subsurface Discharge via Reinjection Wells to the Unconfined Aquifer

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Ground Water F -	Pump and Treat with Subsurface Discharge via Reinjection Wells to the Confined Aquifer
Ground Water G -	Pump and Treat with Direct Surface Water Discharge

3.3.1 Ground Water Alternative A - No Action

Ground Water Alternative A includes a ground water monitoring program. The program will consist of biennial (every other year) sampling and analysis of 10 on-site ground water monitoring wells, with 5 wells in the unconfined aquifer and 5 wells in confined aquifers. Based on previous ground water sampling, as well as State of New Jersey monitoring requirements, the analytical program will include analysis for arsenic, cadmium, lead, pH, conductivity, alkalinity, sulfate, and total dissolved solids. Ground water elevations will also be recorded. As required by the USEPA, the data from the monitoring program will be evaluated and summarized in a report after 5 years of data are collected.

In addition to the monitoring program, institutional controls will be applied to the Site. These institutional controls will include deed restrictions, and may also involve restrictions on water supply or drinking well permits.

3.3.2 Ground Water Alternative B - Pump and Treat with Subsurface Discharge via Infiltration Pond

Ground Water Alternative B includes the monitoring program of Ground Water Alternative A. In addition, the water table will be pumped utilizing the existing well point system (with modifications if determined to be necessary) shown on Figure 29. The existing system consists of 49 well points manifolded into four sub-systems. Combinations of well points will be used to recover ground water and limit off-site migration. For the purpose of this Draft Feasibility Study, a required treatment capacity of 250 gallons per minute is assumed, based on a recovery of 5 gallons per minute per well.

Recovered ground water will be treated to the PQL for lead of 10 ppb, using either a hydroxide or sulfide precipitation/flocculation step followed by an ion exchange polishing step. Treated water will then be discharged to ground water via an infiltration pond of approximately 10 acres. A treatment schematic is shown on Figure 30. Sludge from the precipitation process will be dewatered and managed off-site in a permitted facility. This sludge may require solidification/stabilization prior to land disposal.

Spent ion exchange resin will be regenerated on-site using a concentrated solution of the original exchange ion. Water generated during ion exchange resin regeneration will be collected and transported to the nearby Dupont industrial wastewater treatment facility in Deepwater, NJ or other facility for disposal. Alternatively, regeneration water could be pumped back to the treatment plant head works.

The remedial design will include bench scale treatability tests to evaluate the effectiveness of precipitate/flocculation agents as well as the effectiveness of various ion exchange resins on site ground water.

An infiltration pond was selected for ground water discharge because it is easier to implement than injection wells and absorption fields, and would provide an on-site source of topsoil and cover material. A potential location for the infiltration pond is on the upland property northwest of the existing landfill and hydraulically downgradient of the Site, as illustrated on Figure 31. The location was selected to be outside of all wetland areas. In addition, placing the pond downgradient of the Site will reduce the amount of water to be recovered and will reduce the potential for contaminant migration to deeper aquifers by not increasing the hydraulic head within the plume, as compared to placing it on-site. Additionally, this placement will eliminate the mounding affect which would jeopardize the existing on-site closed landfill facility.

Because organic compounds were detected in wells 11, BR, and SD, recovery well with a submersible pump will be installed in the vicinity of these wells. Recovered ground water will be air stripped to remove volatile organic contaminants prior to treatment to remove metals. An in-line cartridge filter will be installed prior to the air stripper to remove suspended solids, which otherwise could interfere with mass transfer. A cartridge filter and air stripper are included on the process schematic shown on Figure 30.

3.3.3 Ground Water Alternative C - Pump and Treat with Subsurface Discharge via a Leach Field

Ground Water Alternative C includes the monitoring program of Ground Water Alternative A and the recovery and treatment system of Ground Water Alternative B. Recovered ground water will be treated to the PQL for lead of 10 ppb. Discharge of treated ground water will be to the unconfined aquifer via a leach field. Preliminary calculations indicate a 30-acre leach field will be required. This area is not readily available on-site or off-site. Bench scale testing, which may include percolation tests and the confirmation of near surface clay horizons, will be required to fully evaluate this option. The application of treated ground water to the unconfined aquifer will result in a significant mounding effect due to the documented low transmissivity of the aquifer. This mounding, together with the already high water table, could impact existing structures, and threaten the structures and integrity of the existing landfill. In addition, clay content in the upgradient areas potentially increases, further reducing the potential for infiltration at a rate acceptable for the anticipated recovery rate. These factors together with the fact that the required space is not readily available in the upgradient area significantly reduce the potential for implementation of this option. Further bench scale testing will be conducted to fully evaluate this option and confirm the anticipated results of non-applicability.

3.3.4 Ground Water Alternative D - Pump and Treat with Subsurface Discharge via Infiltration Trenches

Ground Water Alternative D includes the monitoring program of Ground Water Alternative A and the recovery and treatment system of Ground Water Alternative B. Recovered ground water will be treated to the PQL for lead of 10 ppb. Discharge of treated ground water will be to the unconfined aquifer via infiltration trenches. Preliminary calculations indicate an area of 20 acres will be required. This area is not readily available at the site. The application of treated ground water to the unconfined aquifer will result in a significant mounding effect due to the documented low transmissivity of the aquifer. This mounding, together with the already high water table, could impact existing structures, and threaten the structures and integrity of the existing landfill. In addition, clay content in the upgradient areas potentially increases, further reducing the potential for infiltration at a rate acceptable for the anticipated recovery rate. These factors together with the fact that the required space is not readily available in the upgradient area significantly reduce the potential for implementation of this option. Further bench scale testing will be conducted to fully evaluate this option and confirm the anticipated results of non-applicability.

3.3.5 Ground Water Alternative E - Pump and Treat with Subsurface Discharge via Reinjection Wells to the Unconfined Aquifer

Ground Water Alternative E includes the monitoring programs of Ground Water Alternative A and the recovery and treatment system of Ground Water Alternative B. Recovered ground water will be treated to the PQL for lead of 10 ppb. Discharge of treated ground water will be to the unconfined aquifer via a reinjection well network. This method will require numerous reinjection wells, appropriately placed upgradient of the source area. The May 1983 pumping test performed at the site indicated an average hydraulic conductivity of about 33 ft/day in the unconfined aquifer. The application of treated ground water to the unconfined aquifer will result in a significant mounding effect due to the documented low transmissivity of the aquifer. This mounding, together with the already high water table, could impact existing structures and threaten the structures and integrity of the existing landfill. In addition, clay content in the upgradient areas potentially increases, further reducing the potential for infiltration at a rate acceptable for the anticipated recovery rate. These factors together with the fact that the required space is not readily available in the upgradient area significantly reduce the potential for implementation of this option. Further bench scale testing will be conducted to fully evaluate this option and confirm the anticipated results of non-applicability.

3.3.6 Ground Water Alternative F - Pump and Treat with Subsurface Discharge via Reinjection Wells to the Confined Aquifer

Ground Water Alternative F includes the monitoring program of Ground Water Alternative A and the recovery and treatment system of Ground Water Alternative B. Recovered ground water will be treated to the PQL action level for lead of 10 ppb. This level of treatment is consistent with the State of New Jersey antidegradation policy which requires a 10 ppb lead discharge limit. Discharge of treated ground water will be to the confined aquifer via a reinjection well network. Studies on the confined aquifer in this area indicate a hydraulic conductivity of about 200 ft/day which is significantly higher than that of the unconfined aquifer. This preliminary information suggests deep well reinjection to the confined aquifer is feasible. Further testing will be required during the remedial design to confirm site specific aquifer characteristics and to confirm discharge criteria.

3.3.7 Ground Water Alternative G - Pump and Treat with Direct Discharge to Surface Water

Ground Water Alternative G includes the monitoring program of Ground Water Alternative A and the recovery and treatment of Ground Water Alternative B. Discharge of treated ground water, however, will be either to the East or West Stream with the discharge criteria of 0.07 ppm lead based on AWQC requirements or the Delaware River with a discharge criteria of 0.10 ppm lead based on the chronic limits proposed by the Delaware River Basin Commission for discharges in the Pedricktown area. AWQC, as discussed above, are hardness dependent and have been evaluated using available flow data and hardness data from streams in the vicinity of the NL Site. The actual discharge point will be selected based on bench scale testing and flow monitoring.

3.4 Sediment Alternatives South of U.S. Route 130

Remec.:ation alternatives for sediments south of U.S. Route 130 are discussed in detail in A. endix I-1. The following alternatives are retained for further consideration:

Sediment A - No Action

Sediment B - Temporary Stream Diversion

Sediment C - Permanent Stream Diversion

3.4.1 Sediment South of U.S. Route 130 Alternative A - No Action

Sediment Alternative A includes surface water monitoring of the East and West Streams on a semi annual (twice per year) basis. The data from the monitoring program will be evaluated and summarized in a report. The report will be written after 5 years as per USEPA requirements and will also include a recommendation concerning future monitoring, if appropriate.

3.4.2 Sediment South of U.S. Route 130 Alternative B - Temporary Stream Diversion

Sediment Alternative B requires the construction of a temporary diversion channel to accommodate natural flow during remediation. When the flow has been diverted, the existing stream segments as illustrated on Figure 32 will be excavated. After the existing stream bed is excavated, flow will be rerouted to the cleaned stream channel and the diversion channel will be backfilled. The filled diversion channel surface will then be restored, which will involve grading and revegetating. Excavated sediments will be tested for hazardous characteristics and managed with Site soils, per the selected Soil Alternative. Figure 32 illustrates the route of the diversion channel.

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The use of dams and temporary piping was considered for diverting stream flow duri sediment excavation to minimize disturbance of the existing habitat. Calculations show that a 1,000,'0 gallon retention pond and pumping capacity of up to 50,000 gpm will be required to accommoc 5% of the 10-year flood flow in this stream. Construction of equipment of this magnitud is not economically or logistically feasible at the NL Industries, Inc. Site. Therefore, construction of a temporary stream diversion channel is used in this alternative.

3.4.3 Sediment South of U.S. Route 130 Alternative C - Permanent Stream Diversion

Sediment Alternative C involves the construction of a permanent stream diversion. A new channel will be constructed near the old stream. The flow from the old channel will be diverted to the new channel and the old channel will then be excavated to meet soil response objectives and filled and regraded with soils that meet soil response objectives. Excavated sediments will be tested for hazardous characteristics and managed with Site soils, per the selected Soil Alternative. The old filled channel and the area disturbed during the construction of the new channel will be restored. Figure 32 illustrates the route of the permanent stream diversion.

3.5 Sediment Alternatives North of U.S. Route 130

Remediation alternatives for sediments north of U.S. Route 130 are discussed in detail in Appendix I-2. The following alternatives are retained for further consideration:

Sediment A - No Action

Sediment B - Mechanical Dredging

3.5.1 Sediment North of U.S. Route 130 Alternative A - No Action

Due to the complexity of the stream systems, the possibility of recontamination from the dredge spoils piles, and the risks associated with sediment remediation, as highlighted in the USEPA Draft Risk Assessment (January 1993), no remedial actions are warranted. However, Sediment Alternative A will include semi-annual (twice per year) surface water monitoring. The data will be evaluated and summarized in a report after 5 years, as per USEPA requirements.

3.5.2 Sediment North of U.S. Route 130 Alternative B - Mechanical Dredging

Sediment Alternative B involves the excavation of sediments with lead concentrations above response objectives. The sediments will be mechanically dredged via a clamshell bucket either from a crane or a floating boom (mudcat) arrangement. Excavated sediments will be tested for hazardous characteristics and managed with site soil, per the selected soil alternative.

3.6 Screening of Alternatives

3.6.1 Introduction

The screening of remedial alternatives is conducted on the basis of effectiveness, implementability, and cost. The intent of screening alternatives is to eliminate alternatives that are significantly less implementable or more costly than comparably effective alternatives.

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Factors included under the criterion of effectiveness are: a) overall reduction in toxicity, mobility, or volume of waste; b) long-term effectiveness and permanence; c) short-term impacts during implementation; and d) how quickly protection can be achieved. Alternatives that do not protect human health and the environment to an acceptable degree are not carried through this initial screening of alternatives.

Implementability takes into account the technical and administrative feasibility of constructing, operating, and maintaining a particular alternative. Technical, administrative, and logistical issues are assessed to characterize the implementability of each alternative. An alternative which will be more difficult or time-consuming to implement than a comparably effective remedy will not be carried through this initial screening.

Cost factors include costs necessary to perform a remedial action, and operating and maintenance costs associated with an action. Cost is used to eliminate alternatives which provide a similar degree of protectiveness at a significantly greater cost. The results of the screening evaluation are discussed below.

3.6.2 Effectiveness

All alternatives except the No Action Alternatives are screened as being effective in protecting human health and the environment. The No Action Alternatives, however, will be carried through to detailed evaluation, in order to provide a basis for comparison for action alternatives.

3.6.3 Implementability

The technologies discussed above are readily implementable for use as remedial alternatives. A further discussion of implementability is provided in Appendices G, H, and I. Likewise, the alternatives formed from these technologies are screened as being implementable.

3.6.4 Cost

Preliminary cost estimates, including capital and annual operation costs, were developed for each alternative, and are included as Tables 6 - 2[illegible]. The total estimated cost of implementing each alternative is as follows:

Soil Alternatives		Est. Cost (1000 ppm)	Est. Cost (500 ppm)
A	No Action/Institutional Controls	$ 179,400	$ 179,400
B	Excavation of All Soils Above Action Level/Soil Washing of All Excavated Soil/Return Treated Soils to Site/Disposal	$13,508,000	$19,485,000
C	Excavation of All Soils Above Action Level/ Off-Site Solidification/Stabilization (S/S) of All Excavated Soil/Disposal	$ 7,444,000	$10,416,000
D	Excavation of All Soils Above Action Level/Soil Washing of Hazardous Soils Requiring Treatment/Consolidation On-Site/Disposal	$ 8,867,000	$10,460,300
E	Excavation of All Soils Above Action Level/ On-Site S/S of Hazardous Soils Requiring Treatment/Off-Site Disposal	$ 8,305,000	$ 9,142,000
F	Excavation of All Soils Above Action Level/ On-Site S/S of Hazardous Soils/Consolidation On-Site	$ 5,188,000	$ 6,128,000
G	Excavation of All Soils Above Action Level/ Off-Site Disposal	$ 9,307.000	$11,582,000
H	Excavation of On-Site Soils Over 1,000 ppm Lead and Off-Site and Wetland Soils over 500 ppm Lead/Treatment of Soils Requiring Treatment/On-site Consolidation/Disposal	$ 9,641,000	

Ground Water Alternatives			
A	No Action	$ 60,000	
B	Subsurface Discharge/Infiltration Pond	$11,933,000	
C	Subsurface Discharge/Leach Field	$13,094,000	
D	Subsurface Discharge/Infiltration Trenches	$12,112,000	
E	Subsurface Discharge/Unconfined/Reinjection Wells	$12,017,000	
F	Subsurface Discharge/Confined/Reinjection Wells	$11,498,000	
G	Direct Discharge to East or West Stream Direct Discharge to Delaware River	$11,592,000 (Streams)	$10,093,000 (Delaware River)

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Sediment South of U.S. Route 130 Alternatives		Est. Cost (1000 ppm)	Est. Cost (500 ppm)
A	No Action	$ 209,000	$ 209,000
B	Temporary Stream Diversion	$1,245,000	$1,390,000
C	Permanent Stream Diversion	$1,251,000	$1,398,000
Sediment North of U.S. Route 130 Alternatives			
A	No Action	$170,000	$170,000
B	Mechanical Dredging	$1,959,000	$3,502,000
Miscellaneous Items		$ 46,000	

3.6.5 Summary

With the exception of the No Action Alternatives, all alternatives pass the initial screening and are retained for further evaluation. The No Action Alternatives, although not effective, will be retained for further evaluation in order to provide a basis for comparison to the remedial alternatives.

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SECTION 4

SECTION 4 - DETAILED EVALUATION OF ALTERNATIVES

4.1 Introduction

Twenty alternatives were developed and screened in Section 3. Each of these alternatives is specific to one of the following four media: soil, ground water, sediment south of U.S. Route 130 and sediments north of U.S. Route 130. Remedial action for the Site will include one alternative for each media plus the remedial action identified for the miscellaneous items discussed in Section 1.2.3.4. These items include the shower tank and the septic system.

The detailed analysis conducted during the evaluation of alternatives provides the basis for remedial alternative selection. In a Feasibility Study, alternatives are evaluated with respect to seven criteria: protection of human health and the environment; compliance with ARARs; long-term effectiveness and permanence; reduction of toxicity, mobility, or volume; short-term effectiveness; implementability; and cost. These criteria are discussed below. Two additional criteria, state acceptance and community acceptance, will be addressed by EPA in the Record of Decision.

Each alternative also addresses the impact to wetlands via the U.S. Army Corps Wetland Evaluation Technique. None of the assessment areas (AA's) were rated as High or Low for all functions evaluated by WET. In general, the downstream areas received higher ratings for effectiveness than upstream areas. The downstream areas are comprised of continuous streams and the portions of the AA's which are inundated with water for substantial periods of time.

A detailed discussion of the WET performed for the Site can be found in Appendix M of this Feasibility Study.

4.1.1 Overall Protection of Human Health and the Environment

The assessment of an alternative against this criterion describes how the alternative, as a whole, protects human health and the environment.

4.1.2 Compliance with ARARs

The assessment of alternatives against this criterion evaluates the compliance of alternatives with ARARs, or the requirement for and justification of a waiver. Specific factors include:

- Compliance with chemical specific ARARs;
- Compliance with action specific ARARs;
- Compliance with location specific ARARs; and
- Consideration of other criteria, advisories, and guidance, as appropriate.

4.1.3 Long-Term Effectiveness and Permanence

The assessment of alternatives against this criterion evaluates the long-term effectiveness of alternatives in protecting human health and the environment after response objectives have been met. Specific factors include:

- Magnitude of remaining risk;
- Adequacy of controls; and
- Reliability of controls.

4.1.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

The assessment of alternatives against this criterion evaluates the anticipated performance of the specific treatment technologies. Specific factors include:

- The treatment processes, the remedies they will employ, and the materials they will treat;
- The amount of hazardous materials that will be destroyed or treated, including how principal threats will be addressed;
- The degree of expected reduction in toxicity, mobility, or volume measured as a percentage of reduction (or order of magnitude);
- The degree to which the treatment will be irreversible; and
- The type and quantity of treatment residuals that will remain following treatment.

4.1.5 Short-Term Effectiveness

The assessment of alternatives against this criterion evaluates the effectiveness of alternatives in protecting human health and the environment during the construction and implementation period until response objectives have been met. Specific factors include:

- Protection of the community during remedial action;
- Protection of workers during remedial action;
- Environmental impacts; and
- Time until remedial response objectives are met.

4.1.6 Implementability

The assessment of alternatives against this criterion evaluates the technical and administrative feasibility of alternatives and the availability of required resources. Specific factors include:

- Ability to construct and operate the technology;
- Reliability of the technology;
- Ease of undertaking additional remedial action if necess ;
- Ability to monitor effectiveness of remedy;
- Ability to obtain approvals from other agencies;
- Coordination with other agencies;
- Availability of off-site treatment, storage, and disposal services and capacity;
- Availability of necessary equipment and specialists; and
- Availability of prospective technologies.

4.1.7 Cost

Alternative costs are evaluated during this assessment. Specific factors include:

- Capital costs;
- Operating and maintenance costs; and
- Present worth costs.

4.2 Soil Remedial Alternatives

Eight alternatives were screened for the remediation of soil. All have been retained for further evaluation. They are:

Soil - A	No Action/Institutional Controls
Soil - B	Excavation of All Soils Above Action Le /Soil Washing of All Excavated Soil/Return Treated Soils to ite/Disposal
Soil - C	Excavation of All Soils Above Action Level/ lidification/ Stabilization (S/S) of All Excavated Soil/Conso idation On-Site

Soil - D	Excavation of All Soils Above Action Level/Soil Washing of Hazardous Soil Requiring Treatment/Consolidation On-Site/Disposal
Soil - E	Excavation of All soils Above Action Level/On-Site S/S of Hazardous Soils Requiring Treatment/Off-Site Disposal
Soil - F	Excavation of All Soils Above Action Level/On-Site S/S of All Hazardous Soils Consolidation On-Site
Soil - G	Excavation of All Soils Above Action Level/Off-Site Disposal
Soil - H	Excavation of On-Site Soils Over 1,000 ppm Lead and Off-Site and Wetland Soils Over 500 ppm Lead/Treatment of Soils Requiring Treatment/On-Site Consolidation/Disposal

Each alternative has been developed for a 1000 ppm lead in soil response objective and a 500 ppm lead in soil response objective. The soil alternatives developed below do not include monitoring programs as ground water monitoring will be sufficient to monitor potential migration of lead found in surface soils.

4.2.1 Soil Alternative A - No Action/Institutional Controls

Soil Alternative A includes the use of fencing along the perimeter of the Site to restrict access to those areas of the Site where soil not meeting response objectives is located. In addition, institutional controls such as deed restrictions will be implemented at the Site. After five years, the effectiveness of this alternative will be reviewed and documented with a report.

4.2.1.1 Overall Protection of Human Health and the Environment

Soil Alternative A does not meet response objectives established to be protective of human health and the environment in the long term. Surface soils at the Site which do not meet response objectives will be fenced, limiting the potential for human contact. However, the alternative does not limit the potential for off-site migration of contaminated soils through wind and surface water erosion. In addition, soil lead concentrations will exceed response objectives identified as being protective of local biota.

4.2.1.2 Compliance with ARARs

The following action specific ARARs will be applicable or potentially applicable, to this alternative:

- Occupational Safety and Health Administration (OSHA) Standards - Hazardous Waste Operations and Emergency Response (29 CFR, 1910.126)
- Occupational Safety and Health Administration (OSHA) Standards - Construction Industry Standards (29 CFR 1926)
- New Jersey Air Pollution Control Regulations (NJAC 7:27 et seq)

The following chemical specific ARARs will be applicable, or potentially applicable, to this alternative:

- National Ambient Air Quality Standards (NAAQS)(40 CFR 50)
- New Jersey Ambient Air Quality Standards (NJAC 7:27-13)

Location specific ARARs are not relevant to Alternative A. However, as discussed above, surface soils at the site do not meet response objectives.

The action-specific ARAR required by Soil Alternative A could be met by following a Health and Safety Plan that meets OSHA requirements.

4.2.1.3 Long-Term Effectiveness and Permanence

Restricting access by fencing could be effective in preventing human contact with soil not meeting response objectives. The No-Action Alternative is not effective in the long term, however, because it does not limit off-site migration of contaminated soils.

4.2.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Implementation of Soil Alternative A will not affect the toxicity, mobility, or volume of the soil at the Site.

4.2.1.5 Short-Term Effectiveness

Soil Alternative A could be implemented almost immediately; the procurement and installation of fencing will require only several months. Soil Alternative A will not result in disturbance of soil, and does not require construction related activities which could generate noise or dust. Likewise, no construction-related impact on the environment is to be expected.

4.2.1.6 Implementability

Soil Alternative A can be implemented easily at the Site. The technical and administrative feasibility of Alternative A is high. Implementation of this alternative will not hinder future remedial action at the Site, if necessary.

4.2.1.7 Cost

The estimated capital cost of Soil Alternative A is $149,000. The annual operation, inspection and fence maintenance costs are estimated at $2,000. Total present worth for 30 years operation at 5% interest is estimated at $30,400. Total cost for this alternative including capital costs and operationsal costs is estimated at $179,400. The basis for this cost estimate is presented on Table 6.

4.2.2 Soil Alternative B - Excavation of All Soils Above Action Level/Soil Washing of All Excavated Soils/Return Treated Soils to Site/Disposal

For the purpose of developing Soil Alternative B, in accordance with instructions from USEPA, it is assumed that all excavated soils will be treated. This corresponds to a volume of approximately 23,100 cubic yards of excavated soil for the 1,000 ppm response objective and 29,800 cubic yards for the 500 ppm response objective to require treatment. This alternative evaluates soil washing as a treatment technology. The remedial design will include a bench scale treatability program to evaluate the effectiveness of various chemical washing agents on the lead containing soil at the Site as well as an on-site demonstration.

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In order to implement this alternative, excavated soil will be screened to remove oversized debris and then mixed with water to form a slurry. The slurry will be transferred to a reactor where it will be subjected to washing agents to remove the lead from the soil. Washed soil will be filtered to remove excess water. The water will be collected and transported in tanker trucks to the nearby DuPont wastewater disposal facility in Deepwater, NJ or another appropriate facility for disposal or treatment at the proposed on-site treatment facility.

The dewatered soil meeting the 1,000 ppm or 500 ppm responsive objective will be tested for hazardous characteristics and non-hazardous soil will be backfilled into the initial excavation area. It is estimated that the soil washing treatment technology will have a treatment efficiency of 70%. Dewatered soils not meeting response requirements will be solidified/stabilized as descried in Alternative C. It is estimated that 9,000 cubic yards of material will require further solidification. The solidification/stabilization process significantly limits the leaching potential of treated soils. Therefore, stabilized soils may be disposed in an on-site consolidation area or at an off-site disposal facility. In costing this remedy it has been assumed that treated soils requiring stabilization will be transported off-site for stabilization and disposal.

The soil washing treatment system will be placed on-site in the vicinity of the existing plant facility (which will be demolished under OU-2). This area is an ideal for location of a treatment system due to its proximity to the soils to be excavated and because utilities (power, water) are available. Figure 25 shows the location of the system. Areas of excavation (and of subsequent backfill with washed soil meeting the response objectives) are shown on Figures 23 and 24.

4.2.2.1 Overall Protection of Human Health and the Environment

Soil Alternative B is evaluated as protective of human health and the environment because it removes soil not meeting response objectives from human contact through removal of lead from soil and subsequent backfill of soil on-site. Contaminated soil and debris are removed from the site. This alternative is protective of the environment because it

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eliminates excessive contamination (above response objectives) from the site, thereby minimizing the potential for off-site migration of contaminated soil through surface runoff.

4.2.2.2 Compliance with ARARs

The following chemical specific ARARs have been identified for this alternative:

- RCRA Identification of Hazardous Waste (40 CFR 261)
- New Jersey Regulation for Hazardous Waste Identification (NJAC 7:26-8)
- National Ambient Air Quality Standards (NAAQS) (40CFR50)
- New Jersey Ambient Air Quality Standards (NJAC 7:27-13)
- Prohibition of Air Pollution (NJAC 7:27-5) (New Jersey)
    - 5.1 Definitions
    - 5.2 General Provisions

Action specific ARARs for the Alternative include:

- RCRA Subtitle C Closure and Post-Closure Standards (40 CFR 264, Subpart G)
- RCRA Standards for Generators of Hazardous Waste (40 CFR 262)
- RCRA Ground Water Monitoring and Protection Standards (40 CFR 264, Subpart F)
- RCRA Transporter Requirements for Manifesting Waste for Off-site Disposal (40 CFR 263)
- RCRA Transporter Requirements for Off-Site Disposal (40 CFR 263)
- RCRA Subtitle D Nonhazardous Waste Management Standards (40 CFR 257)
- RCRA Land Disposal Restrictions (40 CFR 268) (On- and off-site disposal of materials)
- DOT Rules for Hazardous Materials Transport (40 CFR 107, 171.1-171.500)
- Occupational Safety and Health Standards - Hazardous Waste Operations and Emergency Responses (29 CFR 1910.126)
- Occupational Safety and Health Standards - Construction Industry Standards (29 CFR 1926)

- New Jersey RCRA Closure and Post-Closure Standards (NJAC 7:26-1 et.seq.)
- New Jersey Noise Pollution Regulations (NJAC 7:29 et seq.)
- New Jersey Nonhazardous Waste Management Requirements (NJAC 7:26-2)
- New Jersey Air Pollution Control Regulations (NJAC 7:27 et seq.)
- New Jersey Soil Erosion and Sediment Control Act Requirements (NJAC 4:24-42 and NJAC 2:90-1.1 et seq.)
- Executive Orders 11988 and 11990
- USEPA Statement of Policy on Floodplains and Wetlands Assessments CERCLA Actions

Location specifications ARARs are as follows:

- New Jersey Freshwater Wetlands Regulations

In order to comply with these ARARs, the actions required by Soil Alternative B are as follows: a Health and Safety Plan will be written to comply with OSHA requirements. Both the federal and state Ambient Air Quality Standards will be met using dust control measures during excavation, consolidation and grading procedures. Silt fences will be used to control sedimentation and erosion. Any wetlands disturbed will be restored.

4.2.2.3 Long-Term Effectiveness and Permanence

Under this alternative, soil not meeting response objectives will be removed from the site. Washed non-hazardous soil meeting the response objectives (as confirmed by post treatment sampling) will be backfilled on-site. Confirmation sampling of soil remaining on site will verify the long term effectiveness and permanence of the alternative. Post backfill grading and seeding will be used as controls to assure that Site conditions do not change. The effectiveness of the soil treatment method in achieving desired goals is further discussed in Section 4.2.2.6.

4.2.2.4 Reduction of Toxicity, Mobility or Volume Through Treatment

Soil Alternative B will effectively reduce the toxicity and volume of soil not meeting response objectives. Soil Alternative B will not affect the mobility of remaining soil constituents.

4.2.2.5 Short-Term Effectiveness

Implementation of Soil Alternative B will cause minimal impact on the community. To maintain the forested buffer that exists with adjacent properties, the removal of mature on-site trees will be minimized during the implementation of this alternative. Silt fences, hay bales and jute mesh could be used to minimize erosion and surface runoff impacts on adjacent wetlands during construction. The implementation of Soil Alternative B will disturb approximately nine acres of wetlands with low to high value.

Disturbance of soil by excavation, soil staging and treatment are expected to generate dust and noise. Both dust and noise will be controlled by standard techniques. Health and Safety procedures sufficient to insure worker protection will be required.

It is estimated that the soil excavation and treatment could be completed in twelve months. This time estimate does not include additional time necessary to perform studies to demonstrate the effectiveness of the technology (estimated at twelve months), prepare plans and specifications, to obtain Agency approval, to bid the work, and to obtain necessary permits. The total time required to complete the alternative, therefore, is forty-two months (3 1/2 years).

Implementation of Soil Alternative B may affect nine acres of wetlands in wetland areas AA3, AA5, AA6 and AA7.

4.2.2.6 Implementability

Soil Alternative B will be implemented using innovative techniques. Becau Site is approximately one hour from Philadelphia, PA; mobilizing adequate constructi uipment and operators is not anticipated to be difficult.

Previous field studies conducted on lead battery-recycling sites indicates that soil washing may not be effective for removing lead from soils. For example, a bench scale study conducted by PEI Associates on soils from six battery-recycling sites, including this Site, concluded, "It appears that soils from battery-recycling sites that have undergone years of neglect and weathering may not readily respond to soil washing as a remedial treatment technology. Also, Pb probably cannot be physically separated from the soil or concentrated into a smaller volume by particle size separation. It certainly did not partition clearly into any of the three particle size ranges evaluated in this study" (PEI Associates, 1989). In addition, previous tests have shown that materials handling problems during soil washing are especially prevalent for lead contaminated sites with sands and silty s ls. Materials handling concerns could severely impede the effectiveness of the rem ction and increase costs significantly (see "Selection of Control Technologies for Reme n of Lead Battery Recycling Sites," USEPA/540/2-91/014, July 1991). According to t ocument, soil washing has been unsuccessful at the two sites where attempted (Lee's F /ILCO sites). Further, soil washing generally is most effective for soils containi high percentage of coarse sands and gravels. At the Site, only surface soils (0" - 1 depth) are anticipated to require excavation and treatment. Much of the surface soil at the site can be characterized as topsoil or humus, as indicated by bore logs from monitoring wells BR, LD, MD, OD, PD and RD. The surface soils characterized by these bore logs account for approximately half of the surface soil at the Site. Bore logs from other portions of the site indicate that sand is present on the surface. It should be noted, however, that this sand tends to be a fine, silty sand that may not be conducive to soil washing. A review of additional vendor supplied literature shows that limited success has been achieved in isolated cases for acid extraction/soil washing at the bench scale. However, soil washing in general is an unproven technology for remediating lead contamination in soils. There is no proven track record of full scale remediation of lead contaminated soils via soil washing. As such, bench scale evaluations on-site soils would have to be performed to evaluate physical separation effectiveness as well as the effectiveness of various chemical washing agents on removing lead from site soils. Subsequent to bench scale studies, an on-site full scale demonstration would be required to assess the actual performance of a soil washing system on site. The full scale demonstration would be used to assess material handling logistics, chemical usage, waste water generation and overall effectiveness of the process on reducing lead concentration in soils. In this way a track record of performance for full scale soil washing could be established and adjustments made as required to design a fully operable soil washing system.

Significant input from State and local authorities could be expected, due to the size and complexity of the project and the presence of wetlands on-site. A significant administrative coordination effort from the potentially responsible parties will be required to address the concerns of State and local authorities.

4.2.2.7 'ost

The estimated capital cost of Soil Alternative B is $13,431,000 for the 1000 riteria and $19,408,000 for the ̄00 ppm criteria. Annual operating costs are $ Total present worth for 30 years of operation at 5% interest is estimated at $77,0 The total cost for this alternative, including capital and operational costs, is estimatec $13,508,000 and $19,485,000 for the 1,000 ppm and 500 ppm criteria respectively. The basis for these estimates are presented on Tables 7 and 8, respectively.

4.2.3 Soil Alternative C - Excavation of All Soils Above Action Level/Solidification/ Stabilization (S/S) of All Excavated Soil/Consolidation On-Site

For the purpose of developing Soil Alternative C, in accordance with instructions from USEPA, it is assumed that all excavated soils will be treated. This corresponds to a volume of approximately 23,100 cubic yards of soil for the 1,000 ppm response objective and 29,800 cubic yards of soil for the 500 ppm response objective requiring treatment. This alternative evaluates solidification/stabilization as a treatment technology. The remedial design will include a bench scale treatability program to evaluate the effectiveness of various binding agents on solidifying and stabilizing the soils at the Site.

The excavated soils will be treated on-site via S/S, where they will be blended with inding and stabilizing agents and then staged to allow the soil to cure. Upon cu g the stabilized/solidified soil will be subjected to TCLP to confirm that the treated batch meets

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land disposal restrictions. Soils meeting TCLP land disposal requirements consolidated on-site (as described in Alternative D). Figure 27 shows the location of the soil staging area in the vicinity of the existing plant facility which is presently being demolished as part of OU-2. This area is ideal for soils staging and treatment area due to its proximity to the excavation areas and for ease of loading staged soils onto trucks.

4.2.3.1 Overall Protection of Human Health and the Environment

Soil Alternative C is evaluated as being protective of human health and the environment. Excavated soils will be treated, and consolidated on-site thereby removing these soils from human contact.

4.2.3.2 Compliance with ARARs

The following chemical specific ARARs have been identified for this alternative:

- RCRA Identification of Hazardous Waste (40 CFR 261)
- New Jersey Regulation for Hazardous Waste Identification (NJAC 7:26-8)
- National Ambient Air Quality Standards (NAAQS) (40 CFR 50)
- New Jersey Ambient Air Quality Standards (NJAC 7:27-13)

Action specific ARARs for the Alternative include:

- RCRA Subtitle C Closure and Post-Closure Standards (40 CFR 264, Subpart G)
- RCRA Standards for Generators of Hazardous Waste (40 CFR 262)
- RCRA Ground Water Monitoring and Protection Standards (40 CFR 264, Subpart F)
- RCRA Transporter Requirements for Manifesting Waste for Off-site Disposal (40 CFR 263)

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- RCRA Transporter Requirements for Off-Site Disposal (40 CFR 263)

- RCRA Subtitle D Nonhazardous Waste Management Standards (40 C 257)

- RCRA Land Disposal Restrictions (40 CFR 268) (On- and off-site posal of terials)

- DOT Rules for Hazardous Materials Transport (40 CFR 107, 17 1.500)

- Occupational Safety and Health Standards - Hazardous Waste O ns and Emergency Responses (29 CFR 1910.120)

- Occupational Safety and Health Standards - Construction Industry Standards (29 CFR 1926)

- New Jersey RCRA Closure and Post-Closure Standards (NJAC 7:26-1 <u>et.seq.</u>)

- New Jersey Noise Pollution Regulations (NJAC 7:29 <u>et seq.</u>)

- New Jersey Nonhazardous Waste Management Requirements (NJAC 7:26-2)

- New Jersey Air Pollution Control Regulations (NJAC 7:27 <u>et seq.</u>)

- New Jersey Soil Erosion and Sediment Control Act Requirements (NJAC 4:24-42 and NJAC 2:90-1.1 <u>e eq.</u>)

Location specifications are as follows:

- New Jersey Freshwater Wetlands Regulations

The actions required by Soil Alternative C in order to comply with these ARARs are as follows: a Health and Safety Plan will be written to comply with OSHA requirements. Both the federal and state Ambient Air Quality Standards will be met using dust control measures during excavation, consolidation and grading procedures. Silt fences w be used to control sedimentation and erosion. Any wetlands disturbed will be rest . The solidification system will be designed and operated to meet treatment related A Rs.

4.2.3.3 Long-Term Effectiveness and Permanence

Soil Alternative C will be effective in the long-term because soils exceeding response objectives will be treated and consolidated on-site. Soils remaining will meet response objectives.

4.2.3.4 Reduction of Toxicity, Mobility or Volume Through Treatment

Soil Alternative C will not reduce the toxicity of lead through treatment. The mobility of lead will be reduced by solidification/stabilization. However, the volume of material will be significantly increased (50%) as a result of treatment. This is an important consideration when large volumes of soils are being treated for the purpose of reducing mobility.

4.2.3.5 Short-Term Effectiveness

Implementation of Soil Alternative C could cause minimal impact on the community. To maintain the natural buffer that exists with adjacent properties, mature on-site trees will not be removed during or after the implementation of this alternative. Silt fences and other runoff control measures could be used to minimize erosion/sedimentation impact on adjacent wetlands during excavation. The implementation of Soil Alternative C will disturb approximately seven acres of wetlands.

Disturbance of the soil, by excavation and treatment could be expected to generate dust and noise. Both will be controlled by standard techniques. Due to the industrial nature of the Site, any other impacts will not be significant. Health and safety procedures sufficient to insure worker protection will be required.

Construction of on-site equipment necessary to implement this alternative could be completed in nine months. This time estimate does not include time required to prepare plans and specifications, to obtain Agency approval, to bid the work, and to obtain necessary permits. The total time required to complete the alternative, therefore, is approximately two years.

Implementation of Alternative C may affect seven acres of wetlands in wetland areas AA5, AA6, and AA7.

4.2.3.6 Implementability

Soil Alternative C will be implemented using standard construction techniques for excavation and backfill. The soils treatment and staging areas will be constructed to accommodate hazardous soils. Construction of the on-site consolidation area will be accomplished with standard construction techniques. Grading and reseeding will include restoring existing topographic contours and replacing indigenous vegetation with similar vegetation. The site is approximately one hour from Philadelphia, PA; therefore, mobilizing adequate equipment and operators is not anticipated to be difficult.

Significant input from State and local authorities could be expected, due to the size and complexity of the project and the presence of wetlands on-site. A significant administrative coordination effort from the potentially responsible parties will be required to address the concerns of State and local authorities.

4.2.3.7 Cost

The estimated capital cost of Soil Alternative C is $7,367,000 to meet the 1000 ppm criteria and $10,339,000 to meet the 500 ppm criteria. Annual operating costs are estimated at $5,000. The total present worth for 30 years of operation at 5% interest is $77,000. The total cost for this alternative, including capital and operational costs, is $7,444,000 and $10,416,000 for the 1,000 ppm and 500 ppm criteria respectively. The basis for these estimates are presented on Tables 9 and 10, respectively.

4.2.4 Soil Alternative D - Excavation of All Soils Above Action Level/Soil Washing of Hazardous Soil Requiring Treatment/Consolidation On-Site/ Disposal

This alternative assumes that the majority of excavated soils will not require treatment. Excavated soil which is non-hazardous will be consolidated on-site. Excavated soil which is hazardous but passes the EP Toxicity Test will be transported off-site for disposal at a hazardous waste landfill. Excavated soil which is hazardous and fails the EP Toxicity test will be treated on-site using soil washing as described in Soil Alternative B. Treated soils will then be consolidated on-site along with the untreated non-hazardous soil.

The consolidated soil will be placed on-site, east of existing landfill, as indicated on Figure 28. The soil will be consolidated in an area to a height of 29 feet above grade and side slopes as necessary to accommodate the VLDPE membrane. As a contingency measure, a liner system will be placed under the consolidation area, further minimizing leaching of contaminants from the soil. The base will be built up using imported fill to raise the base

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above the 100-year flood plain. It will be necessary to consolidate the soil in one location because it will not be efficient to place a geomembrane cap over separate areas.

The consolidation area will be graded and a geomembrane cover will be placed over it. The geomembrane cover will consist of a 40 mil VLDPE membrane, 24 inches of root zone soils and 6 inches of topsoil followed by seeding, fertilizer and mulch. A drainage layer consisting of 6 inches of gravel will be placed between the geomembrane and root zone soils. This consolidation area will virtually eliminate rainwater leaching of contaminants from the soil. Regular maintenance of vegetative surface will be required. A liner system will be placed under the consolidated area, further minimizing leaching of contaminants from the soil.

Top soil will be brought to the site as necessary to establish vegetation and to facilitate grading. Areas to be excavated to meet the 1,000 ppm and 500 ppm response objectives are presented on Figures 23 and 24 respectively. Excavation to meet the 1000 ppm soil action level will not impact the 100-year floodplain. A total of seven acres of wetlands in wetlands areas AA5, AA6, and AA7 will be impacted by this alternative. Excavation to meet the 500 ppm soil action level will impact portions of the 100-year floodplain in on-site areas north of the railroad tracks. A total of nine acres of wetlands in wetland areas AA3, AA5, AA6, and AA7 will be impacted by excavating to meet the 500 ppm soil action level. Installation of the on-site soil consolidation area will impact additional portions of the floodplain located north of the railroad tracks and will impact wetland area AA5. A plan for the minimization of floodplain impacts will be incorporated into the remedial design for this alternative. A wetlands restoration plan for the impacted wetlands will also be developed as part of the remedial design phase. The management approach for excavated soils is to place them in areas where the public and biota are prevented from coming in contact with them.

4.2.4.1 Overall Protection of Human Health and the Environment

Soil Alternative D is evaluated as protective of human health and the environment because through on-site treatment, on-site consolidation and off-site disposal of excavated soil it removes from human contact soil not meeting response objectives. The geomembrane cap will prevent human contact and will be protective of the environment because it will prevent off-site migration of contaminated soil through surface runoff. In addition, the consolidation area, gravel drainage layer and liner system will limit direct contact with burrowing animals and leaching of contaminants.

4.2.4.2 Compliance with ARARs

The ARAR's for this alternative are the same for those described for Alternative B.

4.2.4.3 Long-Term Effectiveness and Permanence

Soil not meeting response objectives will be removed, treated, and consolidated on-site or disposed of off-site. Confirmation sampling of the remaining soil will verify the long-term effectiveness and permanence of the alternative. The geomembrane cap, as well as soil and surface vegetation maintenance, are reliable controls to assure durability and prevent a change in Site conditions.

4.2.4.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Soil Alternative D will reduce the toxicity, and volume of the soil not meeting the response objectives through treatment of hazardous soils.

The excavation and consolidation required by this alternative will reduce the amount of Site soil which does not meet response objectives. In addition, the installation of a consolidation area will reduce off-site migration of contaminated soils through runoff. This area will minimize rainwater leaching of contaminants from the soil. The installation of a gravel drainage layer and a liner will further minimize leaching as well as deter animals from burrowing, thereby preventing direct contact.

4.2.4.5 Short-Term Effectiveness

Implementation of Soil Alternative D will cause minimal impact on the community. Impact on the forest buffer between the Site and adjacent properties will be minimal. Silt fences and other runoff control measures could be used to minimize erosion/sedimentation impact on adjacent wetlands, if necessary.

Disturbance of soil by excavation is expected to generate dust and noise. Both will be controlled by standard techniques. Due to the industrial nature of the Site, other impacts will not be significant. Health and safety procedures sufficient to insure worker protection will be required. Implementation of Soil Alternative D may affect approximately nine acres of wetlands .

It is estimated that the soil treatment, and consolidation could be completed in nine months. This time does not include additional time required to perform demonstrations, prepare plans and specifications, to obtain Agency approval, to bid the work, and to obtain necessary permits. The total time required to complete the alternative, therefore, is approximately three years.

4.2.4.6 Implementability

Soil Alternative D will be implemented using standard construction techniques only. A base surface area of 2.75 acres and final height above grade of 31 feet with sufficient side slopes will provide adequate capacity within the available on-site area. The base surface area will be built up using imported fill to raise the cover above the 100-year flood plain. The installation of the VLDPE membrane will require additional expertise that is readily available.

The Site is approximately 1 hour from Philadelphia, PA; therefore, mobilizing adequate construction equipment and operators is not anticipated to be difficult.

Due to the size of the project and the presence of wetlands on the site, coordination with other Federal, State, and Local governmental agencies will be required.

4.2.4.7 Cost

For the 1000 ppm criterion, Soil Alternative D has an estimated capital cost of $8,790,000, estimated annual operating and maintenance costs of $5,000, and an estimated present worth (30 years @ 5%) of $77,000. For the 500 ppm criterion, this alternative has an estimated capital cost of $7,091,300, estimated annual operating and maintenance costs of $5000, and an estimated present worth of $77,000. The total cost for this alternative, including capital and operational costs is $8,867,000 and $10,4[illegible],300 for the [illegible]00 ppm criteria and the 500 ppm criteria respectively. The basis for these estimates is presented on Tables 11 and 12, respectively.

4.2.5 Soil Alternative E - Excavation of All Soils Above Action/ Level/On-Site S/S of All Hazardous Soil Requiring Treatment/Off-Site Disposal:

This alternative assumes that the majority of excavated soils will not require treatment. Excavated soil which is non-hazardous will be consolidated on-site as described in Soil Alternative D. Excavated soil which is hazardous but passes the EP Toxicity Test will be transported off-site for disposal at a hazardous waste landfill. Excavated soil which is hazardous and does not pass the EP Toxicity Test will be treated on-site via S/S as described in Soil Alternative B. The on-site S/S treatment system and treated soils staging area will be placed in the vicinity of the existing plant facility (which is presently being demolished under OU-2). This area is ideal for location of a treatment system due to its proximity to the soils to be excavated and because utilities (power, water) are available. Figure 26 shows the location of the system and treated soils staging area.

Areas of excavation are shown on Figures 23 and 24. The location of the on-site cap is shown on Figure 28.

4.2.5.1 Overall Protection of Human Health and the Environment

Soil Alternative E is evaluated as protective of human health and the environment. Hazardous soils will be treated, and disposed off-site thereby removing these soils from human contact. Non-hazardous soils with lead concentrations exceeding the response objectives will be capped, preventing human contact.

4.2.5.2 Compliance with ARARs

The ARARs for this alternative are the same as those identified for Soil Alternative C.

Both the federal and state Ambient Air Quality Standards will be met using dust control measures during excavation, consolidation and grading procedures. Silt fences will be used to control sedimentation and erosion. Any wetlands disturbed will be restored. This may require expanding wetlands south of the railroad tracks to offset those used for the on-site cap which will be constructed to accommodate non-hazardous excavated soils (see Soil Alternative D for a detailed description). The solidification system will be designed and operated to meet treatment related ARARs.

4.2.5.3 Long Term Effectiveness and Permanence

Soil Alternative E will be effective in the long term because hazardous soils will be treated and disposed off-site. Non-hazardous soils with lead concentration exceeding the response objectives will be consolidated on-site as discussed in Alternative D. Soils remaining will meet response objectives.

NLI 002 0682

4.2.5.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Soil Alternative E will reduce the toxicity of lead through treatment. The mobility of lead ill be sufficiently reduced to allow land disposal. The volume of material will be significantly increased (50%) as a sult of t ent.

4.2.5.5 Short-Term Effectiveness

Implementation of Soil Alternative E could cause minimal impact on the community. To maintain the natural buffer that exists with adjacent properties, mature on-site trees will not be removed during or after the implementation of this alternative. Silt fences and other runoff control measures could be used to minimize erosion/sedimentation impact on adjacent wetlands during excavation. The implementation of Soil Alternative E will disturb approximately nine acres of wetlands in wetland areas AA3, AA5, AA6, and AA7.

Disturbance of soil, by excavation is expected to generate dust and noise. Both will be cont. ed by standard techniques. Due to the industrial nature of the Site, other impacts will not be significant. Health and safety procedures sufficient to insure worker protection will be required.

Construction of on-site equipment necessary to implement this alternative could be completed in nine months. This time estimate does not include time required to prepare plans and specifications, to obtain Agency approval to bid the work, and to obtain necessary permits. The total time required to complete the alternative, therefore, is approximately two years.

NLI 002 0683

4.2.5.6 Implementability

Soil Alternative E will be implemented using standard construction techniques for excavation and backfill. On-site treatment will be accomplished using a mobile treatment unit erected on-site. The soils curbing areas will be constructed to accommodate hazardous soils. On-site hauling and disposal will be implemented as discussed for Alternative D. Off-site hauling and disposal will be accomplished with standard construction techniques. Grading and reseeding will include restoring existing topographic contours and replacing indigenous vegetation with similar vegetation. The site is approximately one hour from Philadelphia, PA; therefore, mobilizing adequate equipment and operators is not anticipated to be difficult.

Significant input from State and local authorities could be expected, due to the size and complexity of the project and the presence of wetlands on-site. A significant administrative coordination effort from the potentially responsible parties will be required to address the concerns of State and local authorities.

4.2.5.7 Cost

The estimated capital cost of Soil Alternative E is $8,228,000 for the 1,000 ppm criteria and $9,065,000 to meet the 500 ppm criteria. Annual operating costs are $5,000. The Total present worth for 30 years of operation at 5% interest is $77,000. The total cost for this alternative, including capital and operational costs, is $8,305,000 and $9,142,300 for the 1,000 ppm criteria and 500 ppm criteria respectively. These estimates are presented on Tables 13 and 14, respectively.

4.2.6 Soil Alternative F - Excavation of All Soils Above Action Level/On-Site S/S of All Hazardous Soil/Consolidation On-Site

This alternative assumes that the majority of excavated soils will not require treatment. Excavated soil which is non-hazardous will be consolidated on-site as described in Soil Alternative D. Excavated soil which is hazardous (fails TCLP) will be treated on-site via S/S as described in Soil Alternative B. The on-site S/S treatment system will be placed in the vicinity of the existing plant facility (which is presently being demolished under OU-2). This area is ideal for location of a treatment system due to its proximity to the soils to be excavated and because utilities (power, water) are available. Figure 26 shows the location of the system. Areas of excavation are shown on Figures 23 and 24. The location of the on-site cap is shown on Figure 28.

4.2.6.1 Overall Protection of Human Health and the Environment

Soil Alternative F is evaluated as protective of human health and the environment because through on-site treatment and on-site consolidation, it removes from human contact soil not meeting response objectives. The on-site consolidation area will prevent human contact and will be protective of the environment because it will prevent off-site migration of contaminated soil through surface runoff. In addition, the geomembrane cap, gravel drainage layer and liner system will limit direct contact with burrowing animals and reduce the potential for leaching of contaminants.

4.2.6.2 Compliance with ARARs

The ARARs for this alternative are the same as those identified for Soil Alternative C.

NLI 002 0685

4.2.6.3 Long Term Effectiveness and Permanence

Soil not meeting response objectives will be removed, treated and consolidated on-site or disposed of off-site. Confirmation sampling of the remaining soil will verify the long-term effectiveness and permanence of the alternative. The consolidation area, as well as soil and surface vegetation maintenance, are reliable controls to assure durability and prevent a change in Site conditions.

4.2.6.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Soil Alternative F will reduce the mobility, and volume of the soil not meeting the response objectives through treatment of hazardous soils.

The consolidation required by this alternative will reduce the surface area of the Site covered by soil not meeting response objectives. In addition, the consolidation area will reduce off-site migration of contaminated soils caused by runoff. The cap and liner system will minimize rainwater leaching of contaminants from the soil. The installation of a gravel drainage layer will deter animals from burrowing, thereby preventing direct contact.

4.2.6.5 Short-Term Effectiveness

Implementation of Soil Alternative F will cause minimal impact on the community. Impact on the forest buffer between the Site and adjacent properties will be minimal. Silt fences and other runoff control measures could be used to minimize erosion/sedimentation impact on adjacent wetlands, if necessary.

Disturbance of soil by excavation is expected to generate dust and noise. Both will be controlled by standard techniques. Due to the industrial nature of the Site, other impacts will not be significant. Health and safety procedures sufficient to insure worker protection will be required. Implementation of Soil Alternative F may affect approximately nine acres of wetlands.

Implementation of Soil Alternative F may affect nine acres of wetlands in wetland areas AA3, AA6 and AA7.

It is estimated that the soil treatment, and consolidation could be completed in nine months. This time does not include additional time required to prepare plans and specifications, to obtain Agency approval, to bid the work, and to obtain necessary permits. The total time required to complete the alternative, therefore, is approximately two years.

4.2.6.6 Implementability

Soil Alternative F will be implemented using standard construction techniques only. A base surface area of 2.75 acres and final height above grade of 31 feet with side slopes as necessary will provide adequate capacity within the available on-site area. The base surface area will be built up using imported fill to raise the cover above the 100-year flood plain. The installation of the VLDPE membrane will require additional expertise that is readily available.

The Site is approximately 1 hour from Philadelphia, PA; therefore, mobilizing adequate construction equipment and operators is not anticipated to be difficult.

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Due to the size of the project and the presence of wetlands on the site, coordination with other Federal, State, and Local governmental agencies will be required.

4.2.6.7 Cost

The estimated capital cost of Soil Alternative F is $5,111,000 for the 1000 ppm criteria and $6,051,000 for the 500 ppm criteria. Annual operating costs are $5,000. Total present worth for 30 years of operation at 5% interest is estimated at $77,000. The total cost for this alternative including capital and operational costs, is $5,188,000 and $6,128,000 for the 1,000 ppm criteria and the 500 ppm criteria respectively. The basis for these estimates are presented on Tables 15 and 16, respectively.

4.2.7 Soil Alternative G - Excavation of All Soils Above Action Level/Off-Site Disposal

To implement Alternative G, soil not meeting response objectives will be excavated and transported off-site to an appropriate off-site disposal facility via rail or truck. Non-hazardous soil will be transported to an appropriate permitted landfill. Hazardous land-disposable soil will be transported to a hazardous waste landfill. Hazardous/non-land disposable soil will be transported to an off-site facility for S/S subsequent to final disposal at a hazardous waste landfill. Upon completion of removal, non-wetland portions of the Site will be graded and seeded while wetland portions of the Site will be restored. Topsoil will be brought to the Site as necessary to establish vegetation and to assist in grading. Excavation to meet the 1000 ppm soil action level will not impact the 100-year floodplain. Wetland areas AA5, AA6, and AA7 will be impacted by this alternative. Excavation to meet the 500 ppm soil action level will impact portions of the 100-year floodplain in on-site areas north of the railroad track including wetland areas AA3, AA5, AA6, and AA7.

A plan for the minimization of floodplain impacts will be incorporated into the remedial design for this alternative. A wetlands restoration plan for the impacted wetlands will also be developed as part of the reme design phase.

4.2.7.1 Overall Protection of Human Health and the Environment

Soil Alternative G is evaluated as being protective of human health and the environment.

4.2.7.2 Compliance with ARARs

Chemical specific ARARs include:

- National Ambient Air Quality Standards (NAAQS) (40 CFR 50); and
- New Jersey Ambient Air Quality Standards (NJAC 7:27-13).
- National Ambient Air Quality Standards (40 CFR 50)
- Ambient Air Quality Standards (NJAC 7:27-13) (New Jersey)
- Prohibition of Air Pollution (NJAC 7:27-5) (New Jersey)
    - 5.1 Definitions
    - 5.2 General Provisions

Action specific ARARs will include:

- RCRA Subtitle D Nonhazardous Waste Management Standards (40 CFR 257);
- Occupational Safety and Health Administration (OSHA) Standards - Hazardous Waste Operations and Emergency Response (29 CFR 1910.126)
- Occupational Safety and Health Administration (OSHA) Standards - Construction Industry Standards (20 CFR 1926)
- New Jersey Noise Pollution Regulations (NJAC 7:26-1 et seq.);
- New Jersey Nonhazardous Waste Management Requirements (NJAC 7:26-2);
- New Jersey Air Pollution Control Regulations (NJAC 7:27 et seq.); and

- New Jersey Soil Erosion and Sediment Control Act Requirements (NJAC 4:24-42 and NJAC 2:90-1.1 et seq.).

- Executive Orders 11988 and 11990

- USEPA Statement of Policy on Floodplains and Wetlands Assessments CERCLA Actions

Location specific ARARs include:

- New Jersey Freshwater Wetlands Regulations.

In order to comply with these ARARS, the actions required by Soil Alternative G are as follows: a Health and Safety Plan could be written to meet OSHA standards. Dust control will be utilized to meet the air quality standards; silt fences will be used to control sedimentation and erosion. Any wetlands disturbed during excavation will be restored.

4.2.7.3 Long-Term Effectiveness and Permanence

Landfilling, as proposed in this alternative, is a proven method for long-term containment of both municipal and industrial wastes. Inclusion of the soil in off-site landfills will displace the future disposal of solid waste in those landfills. This must be considered in the overall evaluation of the alternative.

The adequacy and reliability of controls specified by Soil Alternative F depend largely on the landfill selected, and on the future closure of that landfill. Only permitted landfills will be considered for disposal.

4.2.7.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Implementation of Soil Alternative F will not affect the toxicity, mobility, or volume of the soil.

4.2.7.5 Short-Term Effectiveness

Implementation of Alternative F could cause impact on the community due to material transportation requirements. Assuming between 23,100 and 32,800 CY of material to be transported, it is estimated that between 1445 and 2050 truckloads (16 CY/truck) or between 460 and 660 railcars (50 CY/car) will be required. This estimate accounts for the volume expansion of soils (typically 10%) which is observed when soils are excavated. The expansion can be attributed to moisture absorption and the removal of confining pressures on subsurface soils. Transportation of the soil not meeting response objectives will increase traffic and wear on the roads or rail lines in the area. Excavation will cause dust and noise to be generated; however, the impact will be minimized through control measures applied during excavation. Health and safety procedures sufficient to insure worker protection will be required.

The implementation of Soil Alternative G may affect approximately seven acres of wetlands in wetland areas AA5, AA6 and AA7.

It is estimated that the soil excavation, off-site disposal, site restoration, and capping could be completed in nine months. This time does not include additional time required to reach satisfactory contractual arrangements with a landfill that is willing to accept the soil, to prepare plans and specifications, to obtain Agency approval, to bid the work, and to obtain necessary permits. The total time required to complete the alternative, therefore, is approximately two years.

4.2.7.6 Implementability

Soil Alternative G will be implemented entirely using standard construction techniques. Because the Site is approximately 1 hour from Philadelphia, PA; mobilizing adequate construction equipment and operators is not anticipated to be difficult.

According to NJAC 7:26-6.5, all non-hazardous waste generated from within the Salem County municipality of Oldmans (of which Pedricktown is part) must be disposed of at the Salem County regional landfill. The soil would have to be classified as ID-27 waste by the NJDEPE to be accepted as non-hazardous waste. The cost for disposal at the Salem County Landfill is $75/ton. Landfill officials estimate that there is enough capacity remaining in the landfill for approximately 14 years of additional operation. The landfill has a double composite Subtitle D liner/leachate collection system.

Although additional remediation is not anticipated, the implementation of Soil Alternative F is not expected to hinder the undertaking of additional remedial action at the Site, if necessary.

The administrative issues associated with this alternative include obtaining permits for hauling on public roads or railways, reaching satisfactory contractual agreements with the landfill management as well as obtaining implementation approval from Federal, State and local government agencies.

4.2.7.7 Cost

The estimated capital cost of Soil Alternative G is $9,307,000 for the 1000 ppm criteria and $11,582,000 for the 500 ppm criteria. There are no estimated operational costs associated with soils addressed through Alternative G. The total cost for this alternative including capital is $9,307,000 and $11,582,000 for the 1,000 ppm and 500 ppm criteria, respectively. The bases for these cost estimates are presented on Tables 17 and 18, respectively.

4.2.8 Soil Alternative H - Excavation of On-Site Soils Over 1,000 ppm Lead and Off-Site and Wetland Soils Over 500 ppm Lead/Treatment of Excavated Soils Requiring Treatment/ On-Site Consolidation/Disposal:

To implement Alternative H, soil within the property boundaries that have lead concentrations above 1,000 ppm will be excavated. Soil off-site and soil associated with wetlands which exhibit lead concentrations greater than 500 ppm will be excavated. Soil excavated from within the property boundaries (on-site soils) which are non-hazardous will be consolidated on-site. On-site soils which are hazardous will either be treated or disposed of off-site depending on whether such soils are land disposable (fail TCLP but pass EP Toxicity) or require treatment (fail TCLP, fail EP Toxicity). Soil excavated from off-site and soils associated with wetlands (off-site or wetland soils) which have lead concentrations less than 1,000 ppm will be transported on-site for use as fill in the on-site excavation areas. Off-site soils with greater than 1,000 ppm will be transported on-site and addressed with on-site soils. Soils requiring treatment will be addressed either via on-site soil washing or on-site S/S. The treated soils will either be consolidated on-site with non-hazardous soils or transported off-site. The on-site treatment system will be placed in the vicinity of the existing plant facility (which is presently being demolished under OU-2). This area is ideal for location of a treatment system due to its proximity to the soils being excavated and because utilities (power, water) are available. For the purpose of developing Soil Alternative H, it is assumed that 27,500 CY of soils will be excavated of which 11,000 CY will require treatment, 5,500 CY will be hazardous but land disposable and 4,000 CY will be non-hazardous. In addition, 10,000 CY will be considered non-hazardous, and 6,500 CY will be used as on-site backfill. For cost estimating purposes a treatment alternative must be identified. For this evaluation it is most practical to utilize conservative assumptions for comparison purposes. Therefore, soil washing has been utilized in the cost estimate. It should be noted, however, that if solidification/stabilization is selected as the treatment alternative, the costs could be as much as $2,000,000 less.

4.2.8.1 Overall Protection of Human Health and the Environment

The evaluation of protection of human health and the environment for Alternative H is the same as for Soil Alternative D or E depending on the treatment method.

4.2.8.2 Compliance with ARARs

The ARARs for Soil Alternative H are the same as those identified for Soil Alternative D or E depending on the treatment method.

4.2.8.3 Long-Term Effectiveness and Permanence

The evaluation of long term effectiveness and permanence for Soil Alternative H is the same as for Soil Alternative D or E depending on the treatment method.

NLI 002 0694

4.2.8.4 Reduction of Toxicity, Mobility or Volume Through Treatment

The evaluation of reduction of toxicity, mobility and volume through treatment for Soil Alternative H is the same as for Soil Alternative D or E depending on the treatment method.

4.2.8.5 Short-Term Effectiveness

The evaluation of short-term effectiveness for Soil Alternative H is the same as for Soil Alternative D or E depending on the treatment method.

4.2.8.6 Implementability

The evaluation of implementability for Soil Alternative H is the same as for Soil Alternative D or E depending on the treatment method.

4.2.8.7 Cost

The estimated capital cost (assuming soil washing) of Soil Alternative H is $9,564,000. annual operating costs are $5,000. Total present worth for 30 years operation at 5% interest is estimated at $77,000. The total cost for this alternative, including capital and operational costs, is estimated at $9,641,000. The basis for this estimate is presented on Table 18.1.

4.2.9 Summary

The soil alternatives presented above range in cost from $179,000 for Alternative A to $19,485,000 for Alternative B. Alternative A will require 3 months to implement but will not meet ARARs. Alternatives C, D, E, F and G will require between 1-2 years to implement and will meet ARARs. These alternatives range in costs from $5,188,000 for Alternative F to $19,485,000 for Alternative B. All of Alternatives C, D, E, F and G are readily implementable, are protective of human health and the environment will require regulatory involvement and will have a minimal impact on the surrounding community.

Soil Alternative B will require up to 3½ years to implement (including soil washing demonstration tests). Soil Alternative H could also take up to 3½ years to implement if soil washing is selected as the treatment technology. Both Soil Alternatives B and H will meet ARARs, will require some regulatory involvement, are protective of human health and the environment and will have a minimal impact on the surrounding community. The costs for these Alternatives are $19,485,000 and $9,641,000 for Alternatives B and H, respectively. It should also be noted that Alternatives B and D each involve the use of soil washing which has not been proven as an effective treatment technology in full scale use. Therefore, bench and pilot scale testing will be required to prove that the technology will work at the site prior to implementation.

The remaining alternatives all utilize standard, proven technologies. Of those remaining Alternatives C, E, F and H (treatment with S/S) involve the use of solidification/ stabilization for treatment. This technology has been proven and demonstrated to be effective in similar programs of this type. For this reason, implementation could be accomplished using standard engineering and construction techniques.

4.3 Ground Water Remedial Alternatives

Seven ground water alternatives were screened and are retained for development. They are:

Ground Water A - No Action

Ground Water B - Pump and Treat with Subsurface Discharge via Infiltration Pond

Ground Water C - Pump and Treat with Subsurface Discharge via Leach Field

Ground Water D - Pump and Treat with Subsurface Discharge via Infiltration Trenches

Ground Water E - Pump and Treat with Subsurface Discharge via Reinjection Wells to the Unconfined Aquifer

Ground Water F - Pump and Treat with Subsurface Discharge via Reinjection Wells to Confined Aquifer

Ground Water G - Pump and Treat with Direct Discharge to Surface Water

4.3.1 Ground Water Alternative A - No Action

Ground Water Alternative A includes a ground water monitoring program. The program will consist of biennial (every other year) sampling and analysis of ten on-site ground water monitoring wells; five wells in the unconfined aquifer and five wells in the confined aquifer. The analytical program will include arsenic, cadmium, lead, pH, conductivity, sulfate, and total dissolved solids. Ground water elevations will also be recorded. The data from the monitoring program will be evaluated and summarized in a five-year report as required by CERCLA.

In addition to the monitoring program, institutional controls will be applied to the Site. These institutional controls will include deed restrictions.

4.3.1.1 Overall Protection of Human Health and the Environment

Ground Water Alternative A will not be protective of human health in the long term because the ground water does not meet New Jersey Ground Water Standards or Federal MCLs. Biennial ground water monitoring is considered adequate to detect changes in Site conditions.

4.3.1.2 Compliance with ARARs

The following chemical specific ARARs have been identified:

- Safe Drinking Water Act, Maximum Contaminant Levels (MCLs) (40 CFR 141.11-.16)
- New Jersey Groundwater Quality Standards (NJAC 7:9-6).
- Practical Quantitation Limit (PQL) for Lead of 10 ppb

Action specific ARARs include:

- RCRA Groundwater Monitoring and Protection Standards (40 CFR 264, Subpart F); and
- Occupational Safety and Health Administration (OSHA) Standards - Hazardous Waste Operations and Emergency Responses (29 CFR 1910.126)
- Occupational Safety and Health Administration (OSHA) Standards - Construction Industry Standards (29 CFR 1926)

No location specific ARARs have been identified for this alternative.

In order to meet the OSHA requirements, a Health and Safety Plan will be written. In order to gauge ground water quality, regular sampling will be conducted. However, results from previous sampling have indicated lead concentrations above drinking water and ground water standards.

NLI 002 0698

4.3.1.3 Long-Term Effectiveness and Permanence

The long-term effectiveness of the No Action Alternative is considered low since this alternative could allow for the migration of contaminants off-site, even though the water table is generally not used as a drinking water source. The No Action alternative will also not remove the potential for downward migration of contaminants. Two confined aquifers have also been identified at the site as potable water sources. These aquifers are considered part of the Raritan Formation and have been shown to be affected by off-site pumping. Moreover, on-site unconfined aquifer water quality has shown a general trend of substantial improvement over recent years with the exception of cadmium levels in wells 11 and SD which showed a minimal increase in the last round of sampling.

Where implemented, the institutional controls required by the alternative will be very effective in limiting direct contact with contaminated ground water.

4.3.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

This alternative will not reduce the toxicity, mobility, or volume of lead in ground water through treatment.

4.3.1.5 Short-Term Effectiveness

As contaminated ground water will be left in place during implementation of this alternative, short term impacts to the community, workers, and the environment will be minimal. The monitoring required by this alternative will require several days of monitoring on a biennial basis.

4.3.1.6 Implementability

The technical and administrative feasibility of Ground Water Alternative A is high, as only standard sampling techniques are required. Implementation of the No Action Alternative will in no way hinder the undertaking of additional remedial actions, if such actions are deemed necessary.

4.3.1.7 Cost

Capital costs of Ground Water Alternative A are estimated at $10,000. Annual operating costs for this alternative are estimated at $3,245. The total present worth for 30 years operation at 5% interest is estimated at $60,000. The basis for this estimate is presented on Table 19.

4.3.2 Ground Water Alternative B - Pump and Treat with Subsurface Discharge via Infiltration Pond

Ground Water Alternative B will include the monitoring program of Ground Water Alternative A. In addition, the water table will be pumped using the existing well point system (with modifications if required) as shown on Figure 29. The proposed well-point system will impact wetland areas AA2, AA3, AA4, AA5, AA6, AA7, and AA8. [Note that additional wetland areas may be impacted depending on the radius of influence of the extraction system.] The complete WET analysis is presented as Appendix M to this report. A wetlands mitigation plan for the impacted wetlands, if required, will also be developed as part of the remedial design phase. The system shown on Figure 29 consists of 49 well points manifolded into four sub-systems. A valve is located at each well point to control flow; combinations of well points will be used to recover ground water and limit off-site migration. For the purpose of this feasibility study, a required treatment capacity of 250 gallons per minute is assumed, based on an estimated recovery of 5 gallons per minute per well. Information on the existing well point system is provided in Appendix K.

Recovered ground water will be treated to the PQL of 10 ppb lead using a precipitation/flocculation step followed by an ion exchange polishing step and discharged to the ground water via an infiltration pond. A treatment schematic is shown on Figure 30. Sludge from the precipitation process will be dewatered and managed off-site at a permitted facility.

One potential location for the infiltration pond is on the off-site upland property to the northwest of the landfill, which is hydraulically downgradient of the Site. As illustrated on Figure 31, this area is not in wetlands. Placing the pond downgradient of the Site will reduce the amount of water to be recovered and will reduce the potential for contaminant migration to deeper aquifers by preventing an increase of the hydraulic pressure in the area of the on-site contaminant plume. Placing the pond downgradient and off-site will also minimize the effects ground water mounding could have on the existing landfill. In addition, there is insufficient area available on-site for the pond. Bench scale testing, which may include percolation tests and the confirmation of near surface clay horizons, will be required to fully evaluate this option.

NLI 002 0701

Organic compounds were detected in the vicinity of wells 11, BR and SD. To address organic compounds in ground water, a recovery well will be installed in the vicinity of these wells; recovered ground water will be air stripped prior to treatment by precipitation/ flocculation. Air stripping is included on the process schematic shown on Figure 30.

4.3.2.1 Overall Protection of Human Health and the Environment

Ground Water Alternative B will be protective of human health and the environment.

4.3.2.2 Compliance with ARARs

The following chemical specific ARARs have been identified:

- RCRA Identification of Hazardous Waste (40 CFR 261);
- National Ambient Air Quality Standards (NAAQS) (40 CFR 50);
- Safe Drinking Water Act, Maximum Contaminant Levels (MCLs) (40 CFR 141.11-.16)
- (Practical Quantitative Limit (PQL) for Lead (10 ppb)
- New Jersey Regulation for Hazardous Waste Identification (NJAC 7:26-8);
- New Jersey Ambient Air Quality Standards (NJAC 7:27-13); and
- New Jersey Groundwater Quality Standards (NJAC 7:9-6).
- National Ambient Air Quality Standards (40 CFR 50)
- Ambient Air Quality Standards (NJAC 7:27-13) (New Jersey)
- Prohibition of Air Pollution (NJAC 7:27-5) (New Jersey)
  - 5.1 Definitions
  - 5.2 General Provisions

Action specific ARARs include:

- RCRA Land Disposal Restriction (40 CFR 268);
- RCRA Groundwater Monitoring and Protection Standards (40 CFR 264, Subpart F);
- RCRA Standards for Generators of Hazardous Waste (40 CFR 262);

- RCRA Transporter Requirements for Manifesting Waste for Off-Site Disposal (40 CFR 263);
- RCRA Transporter Requirements for Off-Site Disposal (40 CFR 270);
- RCRA Land Disposal Restrictions (40 CFR 268) (On- and Off-Site Disposal of Materials);
- DOT Rules for Hazardous Materials Transport (49 CFR 107, 171.1-171.500);
- Occupational Safety and Health Administration (OSHA) Standards - Hazardous Waste Operations and Emergency Response (29 CFR 1910.126)
- Occupational Safety and Health Administration (OSHA) Standards - Construction Industry Standards (29 CFR 1926)
- New Jersey Noise Pollution Regulations (NJAC 7:29 et seq.);
- New Jersey Air Pollution Control Regulations (NJAC 7:27 et seq.);
- New Jersey Soil Erosion and Sediment Control Act Requirements (NJAC 4:24-42 and NJAC 2:90-1.1 et seq.); and
- New Jersey Groundwater Quality Standards (NJAC 7:9-6).

Action specific "To Be Considered" include:

- Executive Orders 11988 and 11990
- USEPA Statement of Policy on Floodplains and Wetlands Assessments CERCLA Actions

Location specific ARARs include:

- New Jersey Freshwater Wetlands Regulations.
- Farmland Protection Policy Act.

Since this alternative involves the construction and operation of a wastewater treatment plant, ARARs applicable to excavation and construction apply. Also, the possibility exists that sludge, classified as a hazardous waste, will be generated. Therefore, ARARs applicable to the generation, treatment, transportation, and disposal of a hazardous waste must be considered. The ARARs listed above can be met as follows. A Health and Safety Plan will be written in accordance with OSHA requirements. Both federal and state Ambient Air Quality Standards will be met using dust control during excavation. Silt fences will be used to control sedimentation and erosion. Any wetlands disturbedmay be subject to restoration. Before discharge, the water from the wastewater treatment plant will be tested to determine if ground water standards are met. In order to determine when treatment is no longer necessary, ground water sampling and monitoring will be performed periodically to ascertain whether appropriate standards are met.

The Farmland Protection Policy Act institutes a system, implemented by the Soil Conservation Service (SCS), to evaluate the value of farmland proposed for conversion to other uses (including remedial actions under CERCLA). To comply with this requirement, a Farmland Conversion Impact Rating form will be completed for submission to SCS. In addition the following will be completed:

- A U.S. Department of Agriculture Farmland Conversion Impact Rating (FCIR) form will be completed and submitted to the SCS.

- Upon submission of the FCIR form, the SCS will assign a FCIR to the project. Depending on the numerical value of the assigned FCIR, further action, including an evaluation of alternative remedial actions or methods to minimize farmland impacts, may be required.

4.3.2.3 Long-Term Effectiveness and Permanence

This alternative will be effective in the long-term because ground water recovery and treatment could continue as long as response objectives are not met.

4.3.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

This alternative will reduce the toxicity, mobility and volume of the contaminated ground water through treatment. The treatment plant will be designed to decrease contaminant levels to meet drinking water standards. Sludge generated during the treatment process will be disposed of in a landfill off-site.

4.3.2.5 Short-Term Effectiveness

Implementation of Ground Water Alternative B will result in a minimal disruption of the community through construction of water treatment facilities and the infiltration pond. Environmental impact will be limited to a localized change in ground water flow direction.

The construction required to implement this alternative is extensive and could require up to nine months. Preconstruction activity, including time required to prepare plans and specifications, obtain Agency approval, bid the work, and obtain necessary permits, will require approximately one year. Post construction activity, including treatment plant start-up and well field optimization, will require six months to one year. The total anticipated time required to commence groundwater treatment under this alternative, therefore, could approach three years.

4.3.2.6 Implementability

Ground Water Alternative B will be implemented with standard construction techniques to build the water treatment plant. The construction and use of an infiltration pond will also be conducted using standard procedures. Because the Site is approximately one hour from Philadelphia, PA; mobilizing adequate equipment and operators is not anticipated to be difficult.

Treatability studies will be used to select and optimize the combination of precipitation/flocculation agents and ion exchange resins to achieve New Jersey Ground Water Standards.

Ground water Alternative B requires a 10 acre infiltration pond. There is insufficient area available on-site for this pond, and as discussed under section 4.3.2, placement of the pond off-site and downgradient is preferable. The implementability of the alternative depends largely,therefore,on the placement of the pond.

Due to the size and complexity of the project and the presence of wetlands in the vicinity of the Site, significant input from State agencies could be expected.

4.3.2.7 Cost

The estimated capital cost of Ground Water Alternative B is $3,889,000. Annual operating costs are estimated at $523,285. The total present worth for 30 years operation at 5% interest is estimated at $8,044,000. The basis for this estimate is presented on Table 20.

The total cost for this alternative, including capital and operational costs is estimated at $11,933,000.

4.3.3 Ground Water Alternative C - Pump and Treat with Subsurface Discharge via Leach Field

Ground Water Alternative C includes the monitoring program of Ground Water Alternative A and the recovery and treatment system of Ground Water Alternative B. Discharge of treated ground water will be to ground water of the unconfined aquifer via a leach field. Preliminary calculations indicate a 30-acre leach field will be required. Such an area is not readily available downgradient or upgradient of the Site. Bench scale testing, which may include percolation tests and the confirmation of near surface clay horizons, will be required to fully evaluate this option.

4.3.3.1 Overall Protection of Human Health and the Environment

This alternative will be protective of human health and the environment.

4.3.3.2 Compliance with ARARs

The ARAR's for this Alternative are the same as those identified for Groundwater Alternative B.

4.3.3.3 Long-Term Effectiveness and Permanence

This alternative will be effective in the long term because ground water recovery and treatment could be continued as long as response objectives are not being met.

4.3.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

This alternative will reduce the toxicity, mobility, and volume of contaminated ground water through treatment. The treatment plant will be designed to decrease contaminant levels to meet effluent requirements. Sludge generated during the treatment process will be treated and/or disposed in a landfill off-site.

4.3.3.5 Short-Term Effectiveness

Implementation of Ground Water Alternative C could cause minimal impact to the community through the construction of water treatment facilities and the leach field. Environmental impact will be limited to a change in ground water flow direction. The construction required to build a water treatment plant is extensive and could require up to nine months.

Preconstruction activity, including time required to prepare plans and specifications, obtain Agency approval, bid the work, and obtain necessary permits, will require approximately one year. Post construction activity, including treatment plant start-up and well field optimization, will require an additional six months to one year. The total anticipated time required to commence groundwater treatment under this alternative, therefore, could approach three years.

4.3.3.6 Implementability

Ground Water Alternative C will be implemented with standard construction techniques to build the water treatment plant. Because the Site is approximately one hour from

Philadelphia, PA; mobilizing adequate equipment and operators is not anticipated to be difficult.

Ground Water Alternative C requires the construction of a leach field of approximately 30 acres in area. There is insufficient area on-site to implement this option. Off-site lands will need to be evaluated with respect to availability, location and soil characteristics. The desired flushing action associated with this discharge method is directly related to location and permeability of soils. Bench scale testing, which may include percolation tests and the confirmation of near surface clay horizons, will be required to fully evaluate this option. The application of treated ground water to the unconfined aquifer will result in a significant mounding effect due to the documented low transmissivity of the aquifer. This mounding, together with the already high water table, could impact existing structures, and threaten the structures and integrity of the existing landfill. In addition, clay content in the upgradient areas potentially increases further reducing the potential for infiltration at a rate acceptable for the anticipated recovery rate. These factors together with the fact that the required space is not readily available in the upgradient area significantly reduce the potential for implementation of this option. Further bench scale testing will be conducted to fully evaluate this option and confirm the anticipated results of non-applicability. Treatability studies have been conducted and indicate that precipitation/flocculation followed by ion exchange can achieve the PQL of 10 ppb lead. Additional treatability studies will also be used to select and optimize the combination of precipitation/flocculation agents and ion exchange resins.

Due to the size and complexity of the project, and the presence of wetlands in the vicinity of the Site, significant input from State agencies could be expected.

4.3.3.7 Cost

The estimated capital cost of Ground Water Alternative C is $4,453,000. Annual operating costs are estimated at $562,125. The total present worth for 30 years operation at 5% interest is estimated at $8,641,000. The total cost for this alternative, including capital and operational costs, is estimated at $13,094,000. The basis for this estimate is presented on Table 21.

4.3.4 Ground Water Alternative D - Pump and Treat with Subsurface Discharge via Infiltration Trenches

Ground Water Alternative D includes the monitoring program of Ground Water Alternative A and the recovery and treatment system of Ground Water Alternative B. Discharge of treated ground water will be to the ground water of the unconfined aquifer via infiltration trenches. Preliminary calculations indicate an area of 20 acres will be required. Such an area is not readily available downgradient or upgradient of the source. As with Ground Water Alternative C, further bench scale testing will be required to fully evaluate this option.

4.3.4.1 Overall Protection of Human Health and the Environment

This alternative will be protective of human health and the environment.

4.3.4.2 Compliance with ARARs

The ARAR's for this Alternative are the same as those identified for Ground Water Alternative B.

4.3.4.3 Long-Term Effectiveness and Permanence

This alternative will be effective in the long term because ground water recovery and treatment could be continued as long as response objectives are not being met.

4.3.4.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

This alternative will reduce the toxicity, mobility, and volume of contaminated ground water through treatment. The treatment plant will be designed to decrease contaminant levels to meet effluent requirements. Sludge generated during the treatment process will be treated and/or disposed in a landfill off-site.

4.3.4.5 Short-Term Effectiveness

Implementation of Ground Water Alternative D could cause minimal short-term impact on the community due to construction of water treatment facilities and infiltration trenches. Environmental impact will be limited to a localized change in ground water flow direction and a potential increase in East or West Stream flow. The construction required to build a water treatment plant is extensive and could require up to nine months.

Preconstruction activity, including time required to prepare plans and specifications, obtain Agency approval, bid the work, and obtain necessary permits, will require approximately one year. Post construction activity, including treatment plant start-up and well field

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optimization, will require an additional six months to one year. The total anticipated time required to commence groundwater treatment under this alternative, therefore, could approach three years.

4.3.4.6 Implementability

Ground Water Alternative D will be implemented using standard construction techniques to build the water treatment plant. Because the Site is approximately one hour from Philadelphia, PA; mobilizing adequate equipment and operators is not anticipated to be difficult.

Ground Water Alternative D requires an estimated 20 acres for the construction of infiltration trenches. There is insufficient land on-site to implement this option. Off-site lands will need to be evaluated with respect to availability, location and soil characteristics. The desired flushing action associated with this discharge method is directly related to location and permeability of soils. Bench scale testing, which may include percolation tests and the confirmation of near surface clay horizons, will be required to fully evaluate this option. The application of treated ground water to the unconfined aquifer will result in a significant mounding effect due to the documented low transmissivity of the aquifer. This mounding, together with the already high water table, could impact existing structures, and threaten the structures and integrity of the existing landfill. In addition, clay content in the upgradient areas potentially increases further reducing the potential for infiltration at a rate acceptable for the anticipated recovery rate. These factors together with the fact that the required space is not readily available in the upgradient area significantly reduce the potential for implementation of this option. Further bench scale testing will be conducted to fully evaluate this option and confirm the anticipated results of non-applicability. Due to the size and complexity of the project, the presence of wetlands in the vicinity of the Site, and the direct discharge of the plant effluent, significant input from State agencies could be expected.

4.3.4.7 Cost

The estimated capital cost of Ground Water Alternative D is $3,982,000. Annual operating costs are estimated at $528,865. The total present worth for 30 years operation at 5% interest is estimated at $8,130,000. The total cost for this alternative, including capital and operational costs, is estimated at $12,112,000. The basis for this estimate is presented on Table 22.

4.3.5 Ground Water Alternative E - Pump and Treat with Subsurface Discharge via Reinjection Wells to the Unconfined Aquifer

Ground Water Alternative E includes the monitoring programs of Ground Water Alternative A and the recovery and treatment system of Ground Water Alternative B. Discharge of treated ground water will be to the ground water of the unconfined aquifer via a reinjection well network. This method will require numerous reinjection wells, appropriately placed. The high water table in this area and the clay content in the area requires further testing to evaluate the effectiveness of this option. The documented low transmissivity of the unconfined aquifer could result in the significant mounding of reinjected discharge water. This mounding could, due to the already high water table, affect surface structures and the existing landfill.

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4.3.5.1 Overall Protection of Human Health and the Environment

This alternative will be protective of human health and the environment.

4.3.5.2 Compliance with ARARs

The ARAR's for this Alternative are the same as those identified for Ground Water Alternative B.

4.3.5.3 Long-Term Effectiveness and Permanence

This alternative will be effective in the long term because ground water recovery and treatment could be continued as long as response objectives are not being met.

4.3.5.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

This alternative will reduce the toxicity, mobility, and volume of contaminated ground water through treatment. The treatment plant will be designed to decrease contaminant levels to meet effluent requirements. Sludge generated during the treatment process will be treated and/or disposed in a landfill off-site.

4.3.5.5 Short-Term Effectiveness

Implementation of Ground Water Alternative E could cause minimal short-term impact on the community is expected due to construction of water treatment facilities and reinjection wells. Environmental impact will be limited to a change in ground water flow direction and a potential significant increase in water level elevations which could in turn effect existing structures and the landfill. The construction required to build a water treatment plant is extensive and could require nine months.

Preconstruction activity, including time required to prepare plans and specifications, obtain Agency approval, bid the work, and obtain necessary permits, will require approximately one year. Post construction activity, including treatment plant start-up and well field optimization, will require an additional six months to one year. The total anticipated time required to commence groundwater treatment under this alternative, therefore, could approach three years.

4 3.5.6 Implementability

Ground Water Alternative E will be implemented using standard construction techniques to build the water treatment plant. Because the Site is approximately one hour from Philadelphia, PA; mobilizing adequate equipment and operators is not anticipated to be difficult.

Ground Water Alternative E requires the installation of reinjection wells in the unconfined aquifer upgradient of the source area. The lands upgradient of the source area may not be of sufficient size to accommodate injection wells. In addition, the already high water table could mound and impact existing structures. Further evaluation would be required to confirm this increase in clay layer thickness, which is apparent upgradient of the source area. The application of treated ground water to the unconfined aquifer will result in a significant mounding effect due to the documented low transmissivity of the aquifer. This mounding, together with the already high water table, could impact existing structures, and threaten the structures and integrity of the existing landfill. In addition, clay content in the upgradient areas potentially increases further reducing the potential for infiltration at a rate acceptable for the anticipated recovery rate. These factors together with the fact that the required space is not readily available in the upgradient area significantly reduce the potential for implementation of this option. Further bench scale testing will be conducted to fully evaluate this option and confirm the anticipated results of non-applicability. Due to the size and complexity of the project, the presence of wetlands in the vicinity of the Site, and the direct discharge of the plant effluent, significant input from State agencies could be expected.

4.3.5.7 Cost

The estimated capital cost of Ground Water Alternative E is $3,731,000. Annual operating costs are estimated at $539,055. The total present worth for 30 years operation at 5% interest is estimated at $8,286,000. The total cost for this alternative, inclduing capital and operational costs, is estimated at $12,017,000. The basis for this estimate is presented on Table 23.

4.3.6 Ground Water Alternative F - Pump and Treat with Subsurface Discharge via Reinjection Wells to the Confined Aquifer

Ground Water Alternative F includes the monitoring program of Ground Water Alternative A and the recovery and treatment system of Ground Water Alternative B. Discharge of treated ground water will be to the ground water of the confined aquifer via a reinjection well network. Earlier studies on the confined aquifer in this area indicate a hydraulic conductivity of about 200 ft/day in the confined aquifer. This preliminary information suggests deep well reinjection to the confined aquifer will be possible. Further testing will be required during the remedial design to confirm site specific aquifer characteristics and to confirm discharge criteria.

that the required space is not readily available in the upgradient area significantly reduce the potential for implementation of this option. Further bench scale testing will be conducted to fully evaluate this option and confirm the anticipated results of non-applicability. Due to the size and complexity of the project, the presence of wetlands in the vicinity of the Site, and the direct discharge of the plant effluent, significant input from State agencies could be expected.

4.3.5.7 Cost

The estimated capital cost of Ground Water Alternative E is $3,731,000. Annual operating costs are estimated at $539,055. The total present worth for 30 years operation at 5% interest is estimated at $8,286,000. The total cost for this alternative, inclduing capital and operational costs, is estimated at $12,017,000. The basis for this estimate is presented on Table 23.

4.3.6 Ground Water Alternative F - Pump and Treat with Subsurface Discharge via Reinjection Wells to the Confined Aquifer

Ground Water Alternative F includes the monitoring program of Ground Water Alternative A and the recovery and treatment system of Ground Water Alternative B. Discharge of treated ground water will be to the ground water of the confined aquifer via a reinjection well network. Earlier studies on the confined aquifer in this area indicate a hydraulic conductivity of about 200 ft/day in the confined aquifer. This preliminary information suggests deep well reinjection to the confined aquifer will be possible. Further testing will be required during the remedial design to confirm site specific aquifer characteristics and to confirm discharge criteria.

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4.3.6.1 Overall Protection of Human Health and the Environment

This alternative will be protective of human health and the environment.

4.3.6.2 Compliance with ARARs

The ARAR's for this Alternative are the same as those identified for Ground Water Alternative B. However, the New Jersey AntiDegradation Policy for Ground Water (NJAC 6:F-9-2) will also be considered an ARAR for Ground Water Alternative F.

4.3.6.3 Long-Term Effectiveness and Permanence

This alternative will be effective in the long term because ground water recovery and treatment could continue as long as response objectives are not being met.

4.3.6.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

This alternative will reduce the toxicity, mobility, and volume of contaminated ground water through treatment. The treatment plant will be designed to decrease contaminant levels to meet effluent requirements. Sludge generated during the treatment process will be treated and/or disposed in a landfill off-site.

4.3.6.5 Short-Term Effectiveness

Implementation of Ground Water Alternative F will result in minimal short-term impact on the community is expected due to construction of water treatment facilities and reinjection wells. Environmental impacts will be limited to a change in ground water flow direction. The construction required to build a water treatment plant is extensive and could require up to nine months.

Preconstruction activity, including time required to prepare plans and specifications, obtain Agency approval, bid the work, and obtain necessary permits, will require approximately one year. Post construction activity, including treatment plant start-up and well field optimization, will require an additional six months to one year. The total anticipated time required to commence groundwater treatment under this alternative, therefore, could approach three years.

4.3.6.6 Implementability

Ground Water Alternative F will be implemented using standard construction techniques to build the water treatment plant. Because the Site is approximately one hour from Philadelphia, PA; mobilizing adequate equipment and operators is not anticipated to be difficult. Since construction operation and maintenance associated with this alternative will be on-site, implementation of this alternative will not require access agreements or easements. Disruption to the environment off-site is assumed to be negligible since construction of outfalls to streams or rivers normally expected for discharge to surface water will not be necessary for this alternative. On-site operation facilitates emergency repairs and will not require maintenance of an off-site monitoring station.

Ground Water Alternative F requires the installation of reinjection wells in the confined aquifer. Based upon preliminary data from a nearby site, the confined aquifer may be able to accept the anticipated volume of water to be discharged. Further evaluation will be required to confirm the characteristics of the confined unit and its use in this area so that steps can be taken to comply with the State of New Jersey Antidegradation Policy for ground water. Permitting would be less significant due to lack of wetlands, stream

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encroachment and Army Corps of Engineers permits which would be required for discharge to surface water.

4.3.6.7 Cost

The estimated capital cost of Ground Water Alternative F is $3,663,000. Annual operating costs are estimated at $509,725. The total present worth for 30 years operation at 5% interest is estimated at $7,835,000. The total cost for this alternative, including capital and operational costs is estimated at $11,498,000. The basis for this estimate is presented on Table 24.

4.3.7 Ground Water Alternative G - Pump and Treat with Direct Discharge to Surface Water

Ground Water Alternative G includes the monitoring program of Ground Water Alternative A and the recovery and treatment of Ground Water Alternative B. Discharge of treated ground water, however, will be either to the Delaware River or to the East or West Stream. If surface discharge to the East or West Stream is selected, an additional treatment step (reverse osmosis) will be required to achieve discharge limits for total dissolved solids (TDS). If the Delaware River is selected as a discharge point, an effluent treatment outfall would have to be constructed. The actual discharge point will be selected based on additional bench scale testing and flow monitoring.

4.3.7.1 Overall Protection of Human Health and the Environment

This alternative will be protective of human health and the environment.

4.3.7.2 Compliance with ARARs

The following chemical specific ARARs have been identified:

- RCRA Identification of Hazardous Waste (40 CFR 261);
- National Ambient Air Quality Standards (NAAQS) (40 CFR 50);
- Safe Drinking Water Act, Maximum Contaminant Levels (MCLs) (40 CFR 141.11-1.6)
- Practical Quantitation Limit for Lead (10 ppb)
- Clean Water Act, Water Quality Criteria (Section 304) (May 1, 1987 - Gold Book);
- New Jersey Regulation for Hazardous Waste Identification (NJAC 7:26-8);
- New Jersey Surface Water Standards (NJAC 7:9-4); and
- New Jersey Ambient Air Quality Standards (NJAC 7:27-13).
- New Jersey Ground Water Quality Standards (NJAC 7:9-6)
- National Ambient Air Quality Standards (40 CFR 50)
- Ambient Air Quality Standards (NJAC 7:27-13) (New Jersey)
- Prohibition of Air Pollution (NJAC 7:27-5) (New Jersey)
  - 5.1 Definitions
  - 5.2 General Provisions

Action specific ARARs include:

- RCRA Land Disposal Restriction (40 CFR 268);
- RCRA Standards for Generators of Hazardous Waste (40 CFR 262);
- RCRA Transporter Requirements for Manifesting Waste for Off-Site Disposal (40 CFR 263);
- RCRA Transporter Requirements for Off-Site Disposal (40 CFR 270);
- RCRA Land Disposal Restrictions (40 CFR 268) (On- and Off-Site Disposal of Materials);
- DOT Rules for Hazardous Materials Transport (49 CFR 107, 171.1-171.500);

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- Occupational Safety and Health Administration (OSHA) Standards - Hazardous Waste Operations and Emergency Responses (29 CFR 1910.126)

- Occupational Safety and Health Administration (OSHA) Standards - Construction Industry Standards (CFR 1926)

- New Jersey Noise Pollution Regulations (NJAC 7:29 <u>et seq.</u>);

- New Jersey Air Pollution Control Regulations (NJAC 7:27 <u>et seq.</u>); and

- New Jersey Soil Erosion and Sediment Control Act Requirements (NJAC 4:24-42 and NJAC 2:90-1.1 <u>et seq.</u>).

- Executive Orders 11988 and 11990

- USEPA Statement of Policy on Floodplains and Wetlands Assessments CERCLA Actions

Location specific ARARs include:

- New Jersey Freshwater Wetlands Regulations.

Since this alternative involves the construction and operation of a wastewater treatment plant, ARARs applicable to excavation and construction apply. Silt fences will be used to control sediments and erosion. Any wetlands disturbed will be restored. Also, the possibility exists that a sludge, classified as a hazardous waste, may be generated. Therefore, ARARs applicable to the generation, treatment, transportation, and disposal of a hazardous waste must be considered. A Health and Safety Plan will be written in accordance with OSHA requirements. Both federal and state Ambient Air Quality Standards will be met using dust control during excavation. In order to determine if the sludge generated by the wastewater treatment plant is hazardous, the TCLP procedure will be used. Before discharge, water from the wastewater treatment plant will be tested to determine if effluent limitations are being met.

4.3.7.3 Long-Term Effectiveness and Permanence

This alternative will be effective in the long term because ground water recovery and treatment could be conducted as long as response objectives are not being met.

4.3.7.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

This alternative will reduce the toxicity, mobility, and volume of contaminated ground water through treatment. The treatment plant will be designed to decrease contaminant levels to meet effluent requirements. Sludge generated during the treatment process will be treated and/or disposed in a landfill off-site.

4.3.7.5 Short-Term Effectiveness

Implementation of Ground Water Alternative G will result in minimal short-term impact on the community due to construction of water treatment facilities and a treated water discharge outfall. Environmental impacts will be limited to a change in ground water flow direction and a potential increase in East or West Stream flow if the East or West Stream is selected as point of discharge. The construction required to build a water treatment plant and treated water outfall is extensive and could require up to one and one-half years.

Preconstruction activity, including time required to prepare plans and specifications, obtain Agency approval, bid the work, and obtain necessary permits, will require approximately one year. Post construction activity, including treatment plant start-up and well field optimization, will require an additional six months to one year. The total anticipated time required to commence groundwater treatment under this alternative, therefore, could approach four and one-half years.

4.3.7.6 Implementability

Ground Water Alternative G will require standard construction techniques to build the water treatment plant. Because the Site is approximately one hour from Philadelphia, PA; mobilizing adequate equipment and operators is not anticipated to be difficult.

Additional, treatability studies will be required to select and optimize the combination of precipitation/flocculation/ion exchange agents.

Due to the size and complexity of the project, the presence of wetlands in the vicinity of the Site, and the direct discharge of the plant effluent, significant input from State agencies could be expected.

4.3.7.7 Cost

The estimated capital cost of Ground Water Alternative G is $3,741,000 for East or West Stream discharge and $3,525,000 for Delaware River Discharge. Annual operating costs are estimated at $510,705 for the East or West Stream Discharge and $427,245 for Delaware River Discharge. The total present worth for 30 years operation at 5% interest is estimated at $7,851,000 for East or West Stream discharge and $6,568,000 for Delaware River Discharge. Total costs for this alternative, including capital and operational costs, as estimated as $11,592,000 and $10,093,000 for discharge to the East/West Streams and the

Delaware River, respectively. The basis for these estimates is presented on Tables 25 and 26, respectively.

4.3.8 Summary

Ground Water Alternative A is not protective of human health and will not result in the reduced toxicity, mobility, or volume of lead in the ground water. Therefore, Ground Water Alternative A is not discussed further in this summary. Ground Water Alternatives B through G are protective of human health and the environment, can comply with ARARs, are effective in the long term, and will reduce lead toxicity, mobility and volume in the ground water. Short term impact for all Ground Water Alternatives is minimal. The total anticipated time to commence ground water treatment under Alternatives B through F is three years.

Implementability of the options discharging to the unconfined aquifer is a concern for each of these alternatives. Ground Water Alternative B requires discharge off-site to a 10 acre pond preferably downgradient of the site. Implementability of the option depends largely on the placement of the pond. There is insufficient available space on-site for the discharge methods identified in Alternative B, C, D and E. Alternatives C, D and E would benefit remedial action best if construction could occur upgradient of the source area. The space required for discharge Alternatives C, D and E is also not available on-site. In addition to the unavailable space, a major concern is present with respect to the mounding associated with these discharge options. The potential exists that water level: could rise and damage the existing structures and threaten the integrity of the on-site landfill. Ground Water Alternative F and G require further evaluation during Remedia

Design, however, these options do not appear to represent a danger to the on-site structure or the landfill.

The estimated total capital and operating costs identified f-- Alternatives B through F are comparable. Alternative G represents the largest t capital and operation cost expenditure, which is strictly dependent upon which surface water body is selected for discharge.

4.4 Remedial Alternatives for Sediments South of U.S. Route 130

Three alternatives were screened for the remediation of sediments. All have been retained for further evaluation. They are:

Sediment - A	No Action
Sediment - B	Temporary Stream Diversion
Sediment - C	Permanent Stream Diversion

4.4.1 Sediment South of U.S. Route 130 Alternative A - No Action

Sediment Alternative A consists of semi-annual (twice per year) sampling of the surface water in the East and West Stream. Data from the sampling will be evaluated and summarized in a report after five years of data are collected. The report will include a recommendation concerning future monitoring.

4.4.1.1 Overall Protection of Human Health and the Environment

This alternative will not be protective of the environment because portions of the East and West Stream which exceed Ambient Water Quality Criteria and New Jersey surface water standards. However, source removal actions (i.e., soil remediation and OU-2 remediation) will contribute to the enhancement of the surface water quality. Semi-annual sampling of the surface water is considered adequate to detect changes in conditions.

4.4.1.2 Compliance with ARARs

Chemical specific ARARs include:

- Clean Water Act, Water Quality Criteria (Section 304) (May 1, 1987 - Gold Book); and
- New Jersey Surface Water Standards (NJAC 7:9-4).

Action specific ARARs include:

- Occupational Safety and Health Administration (OSHA) Standards - Hazardous Waste Operations and Emergency Responses (29 CFR 1910.126)
- Occupational Safety and Health Administration (OSHA) Standards - Construction Industry Standards (29 CFR 1926)

Action specific TBCs include:

- Executive Orders 11988 and 11990
- USEPA Statement of Policy on Floodplains and Wetlands Assessments CERCLA Actions

A Health and Safety Plan will be written in order to meet the OSHA requirements. In order to gauge compliance with the Clean Water Act and New Jersey Surface Water Standards, regular surface water sampling will be conducted. However, results from

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previous sampling have indicated lead concentrations above these standards in the West Stream and East Stream.

4.4.1.3 Long-Term Effectiveness and Permanence

Sediment Alternative A may not be effective in the long term because lead concentrations in the surface waters will exceed AWQC and New Jersey Surface Water Standards.

4.4.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

This alternative will not reduce the toxicity, mobility or volume of the contaminated surface water through treatment.

4.4.1.5 Short-Term Effectiveness

Sediment Alternative A could be implemented immediately after field equipment for monitoring can be mobilized. Sediment Alternative A does not require construction related activity thus no construction related impact on the environment is expected.

4.4.1.6 Implementability

Sediment Alternative A could be easily implemented at the Site. Implementation of this Alternative will not hinder future remedial action at the Site, if necessary.

4.4.1.7 Cost

Annual operating costs are estimated at $13,580. The total present worth for 30 years operation at 5% interest is estimated at $209,000. The basis for this estimate is presented on Table 27.

4.4.2 Sediment South of U.S. Route 130 Alternative B - Temporary Stream Diversion

Sediment Alternative B involves the temporary diversion of the segments of the East and West Stream which are to be excavated. Based on sample analysis of sediments, the portions of these streams requiring excavation consists of an approximate 1500' reach of the East Stream and an approximate 3600' reach of the West Stream as shown on Figure 32. Excavation of the proposed stream diversion will be conducted in portions of the 100-year floodplain north of the railroad tracks. The diversion will impact approximately sixteen acres of wetlands in wetland areas AA7, AA8, and AA9. The complete WET analysis is presented as Appendix M to this report. A plan for the minimization of floodplain impacts will be incorporated into the remedial design for this alternative. A wetlands restoration plan for the impacted wetlands will also be developed as part of the remedial design phase. A 50 foot strip of land adjacent to the streams will be cleared and access for equipment established. A channel will be excavated that parallels the existing stream beds, and cofferdams will be placed at key points along the courses to allow effective flow re-direction. The actual route of the diversion channels and the location of the cofferdams will be evaluated during remedial design. The flow occurring in the streams will be re-directed into the excavated channels. The stream beds segments shown on Figure 32 will then be excavated. This operation will be conducted in compliance with the requirements of Section 304 of the Clean Water Act. Upon completion of sediment excavation, the cofferdams will be removed to allow the flow to return to the original courses. The cleared strip of land will then be regraded and restored with indigenous vegetation. It is assumed that approximately 900 CY of sediment for the 1,000 ppm response or 1,500 CY of sediment for the 500 ppm response to be removed will be disposed of in accordance with the selected soil remedial alternative.

4.4.2.1 Overall Protection of Human Health and the Environment

This alternative will be protective of human health and the environment. Removal of sediments in the selected stream segments will allow water quality standards to be met while not being overly disruptive to the environment.

4.4.2.2 Compliance with ARARs

The following chemical specific ARARs have been identified:

- National Ambient Air Quality Standards (NAAQS) (40 CFR 50);
- Clean Water Act, Water Quality Criteria (Section 304) (May 1, 1987 - Gold Book);
- New Jersey Surface Water Standards (NJAC 7:9-4); and
- New Jersey Ambient Air Quality Standards (NJAC 7:27-13).
- National Ambient Air Quality Standards (40 CFR 50)
- Ambient Air Quality Standards (NJAC 7:27-13) (New Jersey)
- Prohibition of Air Pollution (NJAC 7:27-5) (New Jersey)
    - 5.1 Definitions
    - 5.2 General Provisions

Action specific ARARs include:

- Occupational Safety and Health Administration (OSHA) Standards - Hazardous Waste Operations and Emergency Responses (29 CFR 1910.126)
- Occupational Safety and Health Administration (OSHA) Standards - Construction Industry Standards (29 CFR 1926)
- New Jersey Air Pollution Control Regulations (NJAC 7:27 et seq.); and
- New Jersey Soil Erosion and Sediment Control Act Requirements (NJAC 4:24-42 and NJAC 2:90-1.1 et seq.).

Action specific TBCs include:

- Executive Orders 11988 and 11990

- USEPA Statement of Policy on Floodplains and Wetlands Assessments CERCLA Actions

Location specific ARARs include:

- New Jersey Freshwater Wetlands Regulations.

A Health and Safety Plan will be written to meet OSHA requirements. Silt fences and silt curtains will be used as necessary to control sedimentation and erosion. Disturbed wetlands will either be restored or replaced with wetlands of a similar make-up.

4.4.2.3 Long-Term Effectiveness and Permanence

Alternative B will be effective in the long term because stream segments which exceed acute AWQC will be excavated and addressed with the chosen soil alternative. The net effect will be that sediments will no longer contribute to elevated lead concentrations in surface waters in the selected stream segments. Because these selected stream segments are hydraulically upgradient, they act as a potential recharge source for the downgradient segments. Overall stream water quality will improve because these sediments will be removed from these upgradient segments.

4.4.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The toxicity, mobility, or volume of lead in sediments will not be reduced through treatment by this alternative. Because the need may exist to solidify the excavated sediment to enhance the manageability and geotechnical characteristics, the volume could double to approximately 1,800 CY for the 1,000 ppm response or 3,000 CY for the 500 ppm response.

4.4.2.5 Short-Term Effectiveness

Appreciable impact on the community during performance of Sediment Alternative B can be expected. A construction easement will be required to allow construction equipment access and space for the diversion channel. The easement will disturb approximately 6 acres of wetlands along the stream courses to allow construction equipment access and space for the diversion channel.

The inherent risk of sediment resuspension and transport downstream during excavation will be avoided during implementation of this alternative by diverting stream flow around the contaminated sediments during excavation.

The construction time for Sediment Alternative B is approximately nine to twelve months. The time required to prepare plans and specifications, obtain Agency approval, bid the work and obtain necessary permits, is approximately one year. The time required to complete Sediment Alternative B is therefore, approximately two years. Implementation of Sediment Alternative B will disturb approximately ten acres of wetlands.

4.4.2.6 Implementability

Equipment access along the stream segment will require providing stabilization using a gravel or geogrid reinforced base along the vehicle route. Standard excavation, hauling, and grading techniques will be used to implement this alternative with attention given to maintaining flow within the diversion channel. Standard erosion/sedimentation control measures will be required.

The anticipated consistency of the exposed sediment in the existing stream beds will be such that solidification with cement (Type I, portland) will be necessary to enhance manageability during loading and hauling and the geotechnical characteristics after final disposal. However, standard construction practices will be sufficient to achieve the solidification.

Due to the size and complexity of the project and the presence of designated wetlands on the Site, input from State agencies could be expected.

4.4.2.7 Cost

The total estimated cost of Sediment Alternative B is $1,245,000 (for the 1,000 ppm response) or $1,390,000 (for the 500 ppm response). There are no operation and maintenance costs associated with this alternative. The basis for the cost estimates are presented in Tables 28 and 28A.

4.4.3 Sediment South of U.S. Route 130 Alternative C - Permanent Stream Diversion

Sediment Alternative C is essentially identical to Sediment Alternative B except Sediment Alternative C includes retaining the diversion channel as the permanent stream courses. The original stream beds will be excavated to meet soil response objectives and backfilled. Excavated sediment will be disposed in accordance with the selected soil remedial alternative.

NLI 002 0732

4.4.3.1 Overall Protection of Human Health and the Environment

This alternative will be protective of human health and the environment as a new channel will be constructed. Constructing a new channel for selected portions of the) and West Stream will allow water quality standards to be met while not being overly di... ve to the environment. Existing sediment will be re-classified as soils since the stream ow is permanently diverted; reclassified sediments not meeting soil response objectives will be removed and disposed of as a soil.

4.4.3.2 Compliance with ..RARs

The following chemical specific ARARs have been identified:

- National Ambient Air Quality Standards (NAAQS) (40 CFR 50);
- Clean Water Act, Water Quality Criteria (Section 304) (May 1, 1987 - Gold Book);
- New Jersey Surface Water Standards (NJAC 7:9-4); and
- New Jersey Ambient Air Quality Standards (NJAC 7:27-13).
- National Ambient Air Quality Standards (40 CFR 50)
- Ambient Air Quality Standards (NJAC 7:27-13) (New Jersey)
- Prohibition of Air Pollution (NJAC 7:27-5) (New Jersey)
  - 5.1 Definitions
  - 5.2 General Provisions

Action specific ARARs include:

- Occupational Safety and Health Administration (OSHA) Standards - Hazardous Waste Operation and Emergency Response (29 CFR 1910.126)
- Occupational Safety and Health Administration (OSHA) Standards - Construction Industry Standards (29 CFR 1926)
- New Jersey Noise Pollution Regulations (NJAC 7:29 et seq.);
- New Jersey Air Pollution Control Regulations (NJAC 7:27 et seq.); and

NLI 002 0733

- New Jersey Soil Erosion and Sediment Control Act Requirements (NJAC 4:24-42 and NJAC 2:90-1.1 et seq.).

Action specific TBCs include:

- Executive Orders 11988 and 11990
- USEPA Statement of Policy on Floodplains and Wetlands Assessments CERCLA Actions

Location specific ARARs include:

- New Jersey Freshwater Wetlands Regulations.

A Health and Safety Plan will be written to meet OSHA requirements. Silt fences and silt curtains will be used as necessary to control sedimentation and erosion. Any wetlands disturbed will be restored.

4.4.3.3 Long-Term Effectiveness and Permanence

Alternative C will be effective in the long term because stream segments will be permanently diverted. The net effect will be that sediments will no longer contribute to elevated lead concentrations in surface waters in the selected stream segments. Because these selected stream segments are hydraulically upgradient, overall stream water quality will improve.

4.4.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The toxicity, mobility, or volume of the lead in the sediments may be reduced through treatment by this alternative. Because the need may exist to solidify the excavated sediment to enhance the manageability and geotechnical characteristics, the volume of reclassified sediment could double to approximately 1,800 CY for the 1,000 ppm response or 3,000 CY for the 500 ppm response.

4.4.3.5 Short-Term Effectiveness

Appreciable impact on the community during the performance of Sediment Alternative C is expected. A construction easement will be required to allow construction equipment access and space for the new stream beds.

The inherent risk of sediment resuspension and transport downstream during excavation will be avoided by this alternative, as the streams will be in new beds prior to excavation.

The construction time for Sediment Alternative C is approximately nine months. Time required to prepare plans and specifications, obtain Agency approval, bid the work and obtain necessary permits is approximately one year. The time required to complete Sediment Alternative C is therefore, approximately two years. Implementation of Sediment Alternative C will disturb approximately ten acres of wetlands.

4.4.3.6 Implementability

Implementability of this alternative is similar to Sediment Alternative B. Additional care will be required when the new permanent channel is installed. The flow characteristics of the original channel will be matched in the new channel to avoid variations in stream hydraulics. The excavation, fine grading and restoration requirements necessary for this alternative will be implemented using standard construction techniques.

Due to the size and complexity of the project and the presence of wetlands on the Site, input from State agencies could be expected.

4.4.3.7 Cost

The total estimated cost of Sediment Alternative C is $1,251,000 (for the 1,000 ppm response) or $1,398,000 (for the 500 ppm response). There are no operation and maintenance costs associated with this alternative. The basis for the estimates are presented on Tables 29 and 29A.

4.4.4 Summary of Sediment Alternatives South of U.S. Route 130

The sediment alternatives presented above range in cost from $209,000 for Alternative A to $1,530,00 for Alternative B to $1,582,000 for Alternative C. Alternative A has no short term impact, is immediately implementable but will not meet ARARs and could impact biota and surface water quality. Sediment Alternatives B and C will result in a minimal short term impact to the surrounding community, can be readily implemented over a 1-2 year period, will meet ARARs and are protective of human health and the environment because sediments exceeding response objectives would be removed. Both alternatives could be implemented using standard construction techniques.

4.5 Remedial Alternatives for Sediments North of U.S. Route 130

Two alternatives were screened for the remediation of sediments. Both have been retained for further evaluation. They are:

Sediment - A	No Action
Sediment - B	Mechanical Dredging

4.5.1 Sediment North of U.S. Route 130 Alternative A - No Action

The evaluation for this alternative is the same as that described for Sediment Alternative A for sediments south of U.S. Route 130.

4.5.2 Sediment North of U.S. Route 130 Alternative B - Mechancial Dredging

Sediment Alternative B involves the excavation of sediments exceeding the action levels of 500 ppm lead and 1,000 ppm lead action levels. The areas requiring excavation, based on sample analysis of sediments, as shown on Figures 32.1 and 32.2. The sediments north of U.S. Route 130 will be excavated in phases according to existing conditions which necessitate different dredging equipment for different stream segments. The phased sediment excavation plan is shown on Figures 32.1 and 32.2, and are as follows:

Phase 1 - Sediments in East Stream North of U.S. Route 130 and Upstream of Corps of Engineers Channel

Phase 2 - Sediments in West Stream North of U.S. Route 130 and Upstream of Corps of Engineers Channel

Phase 3 - Ponded portion of the West Stream

Phase 4 - Corps of Engineers Channel

Sediments in Phases 1, 2 and 4 will be excavated using a crane mounted clamshell bucket. The crane will be wheel mounted and operate from the banks of the stream segment. The sediments in Phase 3 will be excavated using a barge mounted clamshell bucket (mudcat) arrangement. The excavated sediments will be either disposed with other Corps of Engineers dredge spoils or placed in trucks and managed in accordance with the selected soil remedial alternative. For the purposes of costing this alternative, it has been assumed that dredged sediments will be disposed of off-site at secure landfill facilities. It is further assumed that 50% of the sediment will require disposal as hazardous material. Cost for classification of dredged sediments are included. The dredging operation will be conducted in compliance with the requirements of Section 304 of the Clean Water Act. Approximately 3,750 CY for the 1,000 ppm response or 7,500 CY for the 500 ppm response of sediment will be excavated from stream segments north of U.S. Route 130.

4.5.2.1 Overall Protection of Human Health and the Environment

This alternative will be protective of human health. Removal of sediments in the selected stream segments will be potentially disruptive to the environment and may adversely affect stream populations. This is illustrated by the results of Dr. Mark Sprenger in the USEPA's Draft Ecological Risk Assessment Report (January 1993):

> "Any sediment removal efforts should be consider that disturbances of sediment could lower pH and potentially make lead in other areas of the streams more available for uptake, regardless of concentration."

4.5.2.2 Compliance with ARARs

The following chemical specific ARARs have been identified:

- National Ambient Air Quality Standards (NAAQS) (40 CFR 50);
- Clean Water Act, Water Quality Criteria (Section 304) (May 1, 1987 - Gold Book);
- New Jersey Surface Water Standards (NJAC 7:9-4); and
- New Jersey Ambient Air Quality Standards (NJAC 7:27-13).
- National Ambient Air Quality Standards (40 CFR 50)
- Ambient Air Quality Standards (NJAC 7:27-13) (New Jersey)
- Prohibition of Air Pollution (NJAC 7:27-5) (New Jersey)
  - 5.1 Definitions
  - 5.2 General Provisions

Action specific ARARs include:

- Occupational Safety and Health Administration (OSHA) Standards - Hazardous Waste Operations and Emergency Responses (29 CFR 1910.126)
- Occupational Safety and Health Administration (OSHA) Standards - Construction Industry Standards (29 CFR 192^)
- New Jersey Air Pollution Control Regulations (NJAC 7:27 et seq.); and
- New Jersey Soil Erosion and Sediment Control Act Requirements (NJAC 4:24-42 and NJAC 2:90-1.1 et seq.).
- Executive Orders 11988 and 11990
- USEPA Statement of Policy on Floodplains and Wetlands Assessments CERCLA Actions

Location specific ARARs include:

- New Jersey Freshwater Wetlands Regulations.

NLI 002 0739

A Health and Safety Plan will be written to meet OSHA requirements. Silt fences and silt curtains will be used as necessary to control sedimentation and erosion. Disturbed wetlands will either be restored or replaced with wetlands of a similar make-up.

4.5.2.3 Long-Term Effectiveness and Permanence

Alternative B will be effective in the long term because stream segments which exceed acute AWQC will be excavated. The net effect will be that sediments will no longer contribute to elevated lead concentrations in surface waters in the selected stream segments. However, overall stream quality may decrease as described by Dr. Mark Sprenger in the USEPA's Draft Ecological Risk Assessment Report (January 1993):

> "Any sediment removal efforts should be consider that disturbances of sediment could lower pH and potentially make lead in other areas of the streams more available for uptake, regardless of concentration."

4.5.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The toxicity, mobility, or volume of lead in sediments will not be reduced through treatment by this alternative. Because the need may exist to solidify the excavated sediment to enhance the manageability and geotechnical characteristics, the volume could double to approximately 7,500 CY for the 1,000 ppm response or 15,000 CY for the 500 ppm response.

NLI 002 0740

4.5.2.5 Short-Term Effectiveness

Some impact on the community during performance of Sediment Alternative B will be expected. A construction easement will be required to allow dredging equipment :ess. The construction time for s.. .nent Alternative B is approximately nine months 'ime required to prepare plans . specifications obtain a-ency approval, bid the k and obtain necessary permits is approximately one year. The time required to .mplete Sediment Alternative B is approximately two years. Additionally, the impacts from sediment resuspension and tr.nsport downstream during dredging will ne.d to be addressed during remedial design.

4.5.2.6 Implementability

Equipment access along the stream segment may require providing stabilization using a gravel or geogrid reinforced base along the vehicle route. Standard excavation, hauling, and grading techniques will be used to implement this alternative. Standard erosion/sedimentation control measures will be required.

The anticipated consistency of the exposed sediment in the existing stream beds will be such that solidification with cement (Type I, Portland) may be necessary to enhance manageability during loading and hauling and the geotechnical characteristics after final disposal. However, standard construction practices will be sufficient to achieve the solidification.

NLI 002 0741

4.5.2.7 Cost

The estimated remedial cost of Sediment Alternative B for north of U.S. Route 130 is \$1,959,000 (for the 1,000 ppm response) or \$3,502,000 (for the 500 ppm response). There are no operation and maintenance costs associated with this alternative. The basis for the cost estimates are presented in Tables 30 and 31.

4.5.3 Summary

The alternatives evaluated for sediment remediation north of U.S. Route 130 range between zero and \$3,502,000. However, based on the complexity of the streams, the potential for recontamination from sources not related to the Site, and the risks inherent in excavation, as highlighted in the USEPA Draft Ecological Risk Assessment (January 1993), remediation of this media is not justified.

4.6 Comparison of Alternatives

4.6.1 Soil Alternatives

Eight alternatives were developed for the remediation of soils. These alternatives and their estimated costs for a 1000 ppm response objective and a 500 ppm response objective are presented below:

Soil Alternatives		Est. Cost (1000 ppm)	Est. Cost (500 ppm)
A	No Action/Institutional Controls	\$ 179,000	\$ 179,000
B	Excavation of All Soils Above Action Level/Soil Washing of All Excavated Soil/Return Treated Soils to Site/Disposal	\$12,131,000	\$16,874,000
C	Excavation of All Soils Above Action Level/Solidification/Stabilization (S/S) of All Excavated Soil/Consolidation On-Site	\$15,515,000	\$16,077,000

NLI 002 0742

Soil Alternatives		Est. Cost (1000 ppm)	Est. Cost (500 ppm)
D	Excavation of All Soils Above Action Level/Soil Washing of Hazardous Soils Requiring Treatment/Consolidation On-Site/Off-Site Disposal	$ 8,910,000	$10,47 .300
E	Excavation of All Soils Above Action Level/On-Site S/S of All Hazardous Requiring Treatment/Off-Site Disposal	$ 8,305,000	$ [illegible],000
F	Excavation of All Soils Above Action Level/S/S of Hazardous Soils Requiring Treatment/Consolidation On-Site	$ 5,124,000	[illegible]34,000
G	Excavation of All Soils Above Action Level/Off-Site Disposal	$ 8,468,000	$11,095,000
H	Excavation of On-Site Soils Over 1,000 ppm Lead and Off-Site and Wetland Soils Over 500 ppm Lead/Treatment of Soils Requiring Treatment/On-Site Consolidation/Disposal	N/A	$ 9,641,000

The evaluation of soil alternatives according to seven criteria is summarized on Table 33; a comparison of alternatives is discussed below.

Overall Protection of Human Health and the Environment:

The fencing provided by the No Action Alternative will be protective of human health but not protective of the environment. Soil Alternatives B, C, D, E, F, G and H are equally protective of human health and the environment.

Compliance with ARARs:

Seven of the eight Soil Alternatives B, C, D, E, F, G and H will comply with ARARS. Soil Alternative A will not comply with ARARs since a portion of the soils is assumed to be hazardous.

Balancing Criteria:

Soil Alternatives B, C, D, E, F, G and H are roughly equivalent with respect to long term effectiveness and permanence. It is anticipated that the soil, which is not a hazardous waste, will receive the same long term care adjacent to the existing fenced on-site RCRA landfill as will be received at a sanitary landfill. Soil Alternatives C, D and F involve less handling of soil then Alternatives B, C, E, G and H and therefore, fewer short-term adverse impacts.

Soil Alternatives C, E and F increases the volume of soil to be managed by 50% because of the addition of binding agents to the soil.

Soil Alternatives B, C, D, E, F and H are on-site alternatives which could be implemented with minimal disruption to the community. Alternatives F and H would result in less of a disruption to the community than Alternatives B, D or G as these alternatives do not involve the transport of large amounts of materials off-site. Alternatives B, D, E, G and H could involve transport of soils for off-site disposal. Transportation would be performed by truck or rail.

Soil Alternative G is the easiest to implement utilizing standard construction techniques. Soil Alternative B is most difficult to implement because this alternative encompasses on-site treatment, on-site backfill, off-site transportation, off-site treatment and off-site disposal for soils and generated sludges and wastewater. Soil Alternatives D, F and H are slightly more complicated than Alternative G as the alternatives include on-site treatment and on-site consolidation. Soil Alternatives E and G will require the utilization of more off-site resources to implement then Soil Alternatives B, C, D, F or H (i.e sanitary landfill, hazardous waste landfill, transportation equipment).

Soil Alternative F is protective of the environment and human health; in compliance with ARARs, readily implemented, and is the most cost effective.

4.6.2 Ground Water Alternatives

Seven alternatives were developed for the remediation of ground water. These alternatives and their estimated costs are presented below:

Ground Water Alternative	Title	Est. Cost
A	No Action	$60,000
B	Pump and Treat with Subsurface Discharge via Infiltration Pond	$11,933,000
C	Pump and Treat with Subsurface Discharge via Leach Field	$13,094,000
D	Pump and Treat with Subsurface Discharge via Infiltration Trenches	$12,112,000
E	Pump and Treat with Subsurface Discharge to the Unconfined Aquifer via Reinjection Wells	$12,017,000
F	Pump and Treat with Subsurface Discharge to the Confined Aquifer via Reinjection Wells	$11,498,000
G	Pump and Treat with Direct Discharge to East or West Stream or Delaware River	$11,592,000 (Streams) $10,093,000 (Delaware River)

NL1 002 0745

The evaluation of ground water alternatives according to seven criteria is summarized on Table 34; a comparison of alternatives is discussed below.

Overall Protection of Human Health and the Environment:

Ground Water Alternative A will not be protective of human health and the environment. Ground Water Alternatives B through E and G will be equally protective. In addition, Ground Water Alternative F will comply with New Jersey's Antidegradation Policy for Ground Water and is therefore more protective than the other ground water alternatives.

Compliance with ARARs:

Ground Water Alternative A will not comply with ARARs; Ground Water Alternatives B through G will comply with ARARs.

Balancing Criteria:

Ground Water Alternatives B through G are equivalent with respect to long term effectiveness and permanence. These alternatives will reduce the toxicity of ground water but will produce a sludge that would require management, possibly as a hazardous waste. These alternatives are roughly equivalent with respect to short term effectiveness.

Bench scale testing will be required to affirm the implementability of each ground water alternative. The direct discharge prescribed by Ground Water Alternative G will require a more stringent effluent limitation than the subsurface discharge required for discharge to ground water via Alternatives B through F. However, treated water disposal is easier to implement and maintain with direct discharge than with infiltration or reinjection systems which are subject to malfunctioning caused by siltation.

Subsurface Discharge Alternative F and Direct Discharge Alternative G provide the most beneficial results through implementation. Alternative G would result in lower operation and maintenance, and additional land requirements are not a concern. Alternative F also does not require additional land acquisition. It does, however, require an added level of operation and maintenance, as discussed above, with regard to siltation. The reinjection of treated ground water to the confined aquifer could also result in an upward component of flow minimizing potential downward contaminant migration. As discussed earlier, discharge to the unconfined aquifer could create a mound in the already high water table. Alternatives F and G should not result in a mound which would impact surface structures and the existing landfill.

4.6.3 Sediment South of U.S. Route 130 Alternatives

Three alternatives were developed for the remediation of sediment south of U.S. Route 130. These alternatives and their estimated costs are presented below:

Sediment Alternative	Title	Est. Cost (1,000 ppm)	Est. Cost (500 ppm)
A	No Action	$ 209,000	$ 209,000
B	Temporary Stream Diversion	$1,245,000	$1,390,000
C	Permanent Stream Diversion	$1,251,000	$1,398,000

The evaluation of sediment alternatives for south of U.S. Route 130 according to seven criteria is summarized on Table 35; a comparison of alternatives is discussed below.

Overall Protection of Human Health and the Environment:

Sediment Alternative A will not be protective of human health and the environment. Sediment Alternatives B and C will be equally protective.

Compliance with ARARs:

Sediment Alternative A will not comply with ARARs, because West Stream surface water exceeds New Jersey Surface Water Standards. Sediment Alternatives B and C will comply with ARARs.

Balancing Criteria:

Sediment Alternatives B and C are equally effective with respect to long term effectiveness and permanence. Both alternatives could achieve reduction of toxicity or volume though treatment by the selected soil Alternative.

Sediment Alternative B is more easily implemented and more cost effective than Sediment Alternative C.

4.6.4 Sediment North of U.S. Route 130 Alternatives:

Two alternatives were developed for the remediation of sediment north of Route 130. These alternatives and their estimated costs are presented below:

Sediment Alternative	Title	Est. Cost (1,000 ppm)	Est. Cost (500 ppm)
A	No Action	$ 170,000	$ 170,000
B	Mechanical Dredging	$1,959,000	$3,502,000

The evaluation of sediment alternatives for north of U.S. Route 130 according to seven criteria is summarized on Table 36; a comparison of alternatives is discussed below.

NLI 002 0748

Overall Protection of Human Health and the Environment:

Sediment Alternative A will not be protective of human health, but could be protective of the environment as stated previously. Sediment Alternative B may not be protective of the environment.

Compliance with ARARs:

Sediment Alternative A will not comply with ARARs. Sediment Alternative B will comply with ARARs.

Balancing Criteria:

Sediment Alternative B is more effective with respect to long term effectiveness and permanence. Alternative B could achieve reduction of toxicity or volume through treatment by soil Alternatives B through F. However, as stated previously, due to the complexity of the stream systems, the potential recontamination from sources not related to the Site, and the inherent risks of excavation, remediation is not fully justified.

NLI 002 0749

TABLES

NL Industries, Inc. Site

On-Site Soil Analyses

Sample ID	Sample Type	Sample Date	Laboratory Number	Sample Depth(in)	Lead concentration (ppm dry weight)
201	on-site	9-12-88	T0050	0-3	21
		9-12-88	T0051	3-6	12
202	on-site	9-12-88	T0054	0-3	19
		9-12-88	T0055	3-6	15
203	on-site	9-12-88	T0058	0-3	25
		9-12-88	T0059	3-6	16
204	on-site	9-14-88	T0185	0-3	153
		9-14-88	T0186	3-6	45
205	on-site	9-14-88	T0062	0-3	29
		9-14-88	T0063	3-6	18
206	on-site	9-14-88	T0181	0-3	60
		9-14-88	T0182	3-6	30
207	on-site	9-14-88	T0189	0-3	100
		9-14-88	T0190	3-6	26
208	on-site	9-12-88	T0066	0-3	22
		9-12-88	T0067	3-6	16
209	on-site	9-14-88	T0173	0-3	634
		9-14-88	T0174	3-6	756
		9-14-88	T0175	6-12	131
		9-14-88	T0176	12-18	83
210	on-site	9-12-88	T0070	0-3	33
		9-12-88	T0071	3-6	25
211	on-site	9-14-88	T0169	0-3	7500
		9-14-88	T0170	3-6	5910
		9-14-88	T0171	6-12	5320
		9-14-88	T0172	12-18	1820
		8-17-89	I9418	18-24	22.3
		8-17-89	I9419	24-30	45.3
		11-1-90	L5955	18-24	118
		11-1-90	L5954	24-30	34.5
212	on-site	9-13-88	T0128	0-3	333
		9-13-88	T0129	3-6	172
		9-13-88	T0130	6-12	68
		9-13-88	T0131	12-18	34
213	on-site	9-12-88	T0074	0-3	1800
		9-12-88	T0075	3-6	2040
		9-12-88	T0076	6-12	R
		9-12-88	T0077	12-18	R
		8-17-89	I9430	18-24	891
		11-1-90	L5957	18-24	18.1
214	on-site	9-14-88	T0140	0-3	572
		9-14-88	T0141	3-6	120
215	on-site	9-14-88	T0193	0-3	1730
		9-14-88	T0194	3-6	383
		9-14-88	T0195	6-12	39
		9-14-88	T0196	12-18	28

Table 1-1 5/12/93

(continued)

NL Industries, Inc. Site

On-Site Soil Analyses

Sample ID	Sample Type	Sample Date	Laboratory Number	Sample Depth(in)	Lead concentration (ppm dry weight)
216	on-site	9-14-88	T0144	0-3	2080
		9-14-88	T0145	3-6	165
217	on-site	9-14-88	T0165	0-3	12700
		9-14-88	T0166	3-6	12300
		9-14-88	T0167	6-12	6880
		8-17-89	I9424	12-18	2940
		8-17-89	I9427	12-18	246
		8-17-89	I9425	18-24	231
		8-17-89	I9428	18-24	102
		8-17-89	I9426	24-30	302
		8-17-89	I9429	24-30	173
		11-1-90	L5960	12-18	101
		11-1-90	L5970	18-24	298
		11-1-90	L5962	24-30	672
218	on-site	9-14-88	T0197	0-3	9340
		9-14-88	T0198	3-6	1620
		9-14-88	T0199	6-12	4370
		9-14-88	T0200	12-18	R
		8-17-89	I9420	18-24	2.91
		8-17-89	I9421	24-30	6.01
		11-1-90	L5953	18-24	39.2
		11-1-90	L5958	24-30	17.4
219	on-site	9-14-88	T0149	0-3	740
		9-14-88	T0150	3-6	99
220	on-site	9-14-88	T0161	0-3	3590
		9-14-88	T0162	3-6	2840
		9-14-88	T0163	6-12	R
		9-14-88	T0164	12-18	R
		8-17-89	I9422	18-24	15.9
		8-17-89	I9423	24-30	51.5
		11-1-90	L5958	18-24	3.26
		11-1-90	L5959	24-30	277
221	on-site	9-14-88	T0153	0-3	1580
		9-14-88	T0154	3-6	793
		9-14-88	T0155	6-12	117
		9-14-88	T0156	12-18	49
222	on-site	9-14-88	T0157	0-3	4610
		9-14-88	T0158	3-6	226
		9-14-88	T0159	6-12	84
		9-14-88	T0160	12-18	152
223	on-site	9-14-88	T0177	0-3	1220
		9-14-88	T0178	3-6	170
		9-14-88	T0179	6-12	56
		9-14-88	T0180	12-18	20
301	on-site	9-13-88	T0086	0-2	401
302	on-site	9-12-88	T0088	0-2	44.2
303	on-site	9-13-88	T0089	0-2	72.1
304	on-site	9-12-88	T0087	0-2	238
305	on-site	9-13-88	T0090	0-2	367
306	on-site	9-13-88	T0091	0-2	845
307	on-site	9-13-88	T0092	0-2	119
308	on-site	9-13-88	T0093	0-2	1190
308	on-site	9-12-88	T0094	0-2	480

Note: R - indicates data rejected based on data validation

NLI 002 0752

NL Industries, Inc. Site
Off-Site Soil Analyses

Sample ID	Sample Type	Sample Date	Laboratory Number	Sample Depth(in)	Lead concentration (ppm dry weight)
1	off-site	9-16-88	T0371	0-3	22.8
		9-16-88	T0372	3-6	12.9
1	off-site	9-16-88	T0375	0-3	31.2
		9-16-88	T0376	3-6	11.5
2	off-site	9-16-88	T0367	0-3	58.6
		9-16-88	T0368	3-6	24.6
3	off-site	9-16-88	T0359	0-3	35.7
		9-16-88	T0360	3-6	29.7
4	off-site	9-16-88	T0363	0-3	89
		9-16-88	T0364	3-6	23.1
5	off-site	9-16-88	T0355	0-3	55.4
		9-16-88	T0356	3-6	13.4
6	off-site	9-15-88	T0289	0-3	538
		9-15-88	T0290	3-6	88.8
		9-15-88	T0291	6-12	44.4
		9-15-88	T0292	12-18	25
7	off-site	9-15-88	T0285	0-3	685
		9-15-88	T0286	3-6	215
		9-15-88	T0287	6-12	133
		9-15-88	T0288	12-18	21.5
8	off-site	9-15-88	T0281	0-3	121
		9-15-88	T0282	3-6	41.5
9	off-site	9-15-88	T0309	0-3	48.4
		9-15-88	T0310	3-6	23.1
10	off-site	9-15-88	T0305	0-3	26.6
		9-15-88	T0306	3-6	27.8
11	off-site	9-15-88	T0245	0-3	57.9
		9-15-88	T0246	3-6	43.3
11	off-site	9-15-88	T0249	0-3	54.4
		9-15-88	T0250	3-6	42.5
12	off-site	9-15-88	T0233	0-3	72.9
		9-15-88	T0234	3-6	28.4
13	off-site	9-15-88	T0317	0-3	32.3
		9-15-88	T0318	3-6	28.2
14	off-site	9-15-88	T0229	0-3	26.8
		9-15-88	T0230	3-6	26.4
15	off-site	9-12-88	T0078	0-3	32.6
		9-12-88	T0079	3-6	33.1
16	off-site	9-12-88	T0082	0-3	130
		9-12-88	T0083	3-6	21
17	off-site	9-15-88	T0213	0-3	175
		9-15-88	T0214	3-6	44.5

Table 1-2 5/12/93
(continued)
NL Industries, Inc. Site
Off-Site Soil Analyses

Sample ID	Sample Type	Sample Date	Laboratory Number	Sample Depth(in)	Lead concentration (ppm dry weight)
18	off-site	9-15-88	T0321	0-3	46
		9-15-88	T0322	3-6	29.2
19	off-site	9-15-88	T0329	0-3	45.3
		9-15-88	T0330	3-6	29.5
20	off-site	9-15-88	T0325	0-3	88.4
		9-15-88	T0326	3-6	38.1
21	off-site	9-15-88	T0205	0-3	41.2
		9-15-88	T0206	3-6	40.3
22	off-site	9-15-88	T0201	0-3	46.3
		9-15-88	T0202	3-6	50.8
24	off-site	9-13-88	T0112	3-6	367
		9-13-88	T0113	3-6	132
25	off-site	9-13-88	T0120	0-3	307
		9-13-88	T0121	3-6	317
		9-13-88	T0122	6-12	244
		9-13-88	T0123	12-18	80.6
26	off-site	9-13-88	T0116	0-3	68.4
		9-13-88	T0117	3-6	62.8
27	off-site	9-15-88	T0333	0-3	206
		9-15-88	T0334	3-6	226
		9-15-88	T0335	6-12	142
		9-15-88	T0336	12-18	59.8
28	off-site	9-15-88	T0209	0-3	275
		9-15-88	T0210	3-6	106
29	off-site	9-13-88	T0104	0-3	161
		9-13-88	T0105	3-6	103
30	off-site	9-13-88	T0108	0-3	81.6
		9-13-88	T0109	3-6	74.4
31	off-site	9-15-88	T0241	0-3	77.9
		9-15-88	T0242	3-6	78.2
32	off-site	9-15-88	T0217	0-3	48.1
		9-15-88	T0218	3-6	21.5
33	off-site	9-15-88	T0237	0-3	32.7
		9-15-88	T0238	3-6	32.6
34	off-site	9-15-88	T0221	0-3	30.9
		9-15-88	T0222	3-6	31.6
35	off-site	9-15-88	T0225	0-3	22.9
		9-15-88	T0226	3-6	25.7
36	off-site	9-13-88	T0341	0-3	40.9
		9-13-88	T0342	3-6	40.2

Table 1-2 5/12/93
(continued)
NL Industries, Inc. Site
Off-Site Soil Analyses

Sample ID	Sample Type	Sample Date	Laboratory Number	Sample Depth(in)	Lead concentration (ppm dry weight)
37	off-site	9-15-88	T0337	0-3	74.7
		9-15-88	T0338	3-6	68.6
38	off-site	9-15-88	T0350	0-3	72.1
		9-15-88	T0351	3-6	71.1
39	off-site	9-15-88	T0346	0-3	48.2
		9-15-88	T0347	3-6	43.1
40	off-site	9-15-88	T0273	0-3	106
		9-15-88	T0274	3-6	98.1
41	off-site	9-15-88	T0269	0-3	145
		9-15-88	T0270	3-6	134
42	off-site	9-15-88	T0261	0-3	175
		9-15-88	T0262	3-6	167
43	off-site	9-15-88	T0257	0-3	221
		9-15-88	T0258	3-6	199
44	off-site	9-15-88	T0265	0-3	1770
		9-15-88	T0266	3-6	833
		8-17-89	I9416	6-12	50.7
		8-17-89	I9417	12-18	68.6
		11-2-90	L5943	6-12	166
		11-2-90	L5944	12-18	46.1
44A	off-site	8-17-89	I9412	0-3	203
		8-17-89	I9413	3-6	31.7
		8-17-89	I9414	6-12	23.1
		8-17-89	I9415	23-28	10.7
45	off-site	9-15-88	T0253	0-3	108
		9-15-88	T0254	3-6	37
46	off-site	9-15-88	T0277	0-3	87
		9-15-88	T0278	3-6	25
47	off-site	9-15-88	T0313	0-3	457
		9-15-88	T0314	3-6	382
		9-15-88	T0315	6-12	55.4
		9-15-88	T0316	12-18	19.2
48	off-site	9-15-88	T0301	0-3	26
		9-15-88	T0302	3-6	35
49	off-site	9-15-88	T0297	0-3	25
		9-15-88	T0298	3-6	28
50	off-site	9-15-88	T0293	0-3	34
		9-15-88	T0294	3-6	29

Table 1-2 (continued)

5/12/93

NL Industries, Inc. Site

Off-Site Soil Analyses

Sample ID	Sample Type	Sample Date	Laboratory Number	Sample Depth(in)		Lead concentration (ppm dry weight)
51-59	Not Used					
60	off-site	11-2-90	L5929	0-3		294
		11-2-90	L5930	3-6		51.4
		11-2-90	L5927	6-12	J	5.67
		11-2-90	L5928	12-18	J	4.64
61	off-site	11-2-90	L5932	0-3		844
		11-2-90	L5931	3-6		105
		11-2-90	L5933	6-12		17.6
		11-2-90	L5934	12-18	J	3.09
62	off-site	11-2-90	L5935	0-3		221
		11-2-90	L5936	0-3		414
		11-2-90	L5937	3-6		129
		11-2-90	L5938	3-6		46.7
		11-2-90	L5939	6-12	J	2.98
		11-2-90	L5940	6-12	J	9.77
		11-2-90	L5941	12-18	J	2.24
		11-2-90	L5941	12-18	J	4.17
63	off-site	11-2-90	L5949	0-3		1110
		11-2-90	L5950	3-6		353
		11-2-90	L5951	6-12		131
		11-2-90	L5952	12-18		35
64	off-site	11-2-90	L5945	0-3		1240
		11-2-90	L5946	3-6		494
		11-2-90	L5947	6-12		79.5
		11-2-90	L5948	12-18		33.3

Table 1-3 5/12/93

NL Industries, Inc. Site

Soil Supplemental Metal Analyses

Sample ID	Sample Type	Coordinates Horiz.-Vert.	Sample Date	Laboratory Number	Sample Depth(in.)	Arsenic (ppm)	Antimony (ppm)	Cadmium (ppm)	Chromium (ppm)	Copper (ppm)	Selenium (ppm)	Tin (ppm)	Zinc (ppm)
32	Off-site	7330-10490	9/14/88	T0217	0-3	5.69	<20	<1	7.87	6.83J	<0.5J	<80	16.7
22	Off-site	8280-9710	9/14/88	T0201	0-3	6.31	<20	<1	5.86	5.60J	<0.5J	<80	14.8
3	Off-site	9340-7380	9/14/88	T0359	0-3	1.65	<20	<1	7.04	3.25J	<0.5J	<80	21.0
36	Off-site	9570-11400	9/15/88	T0341	0-3	3.68	<20	<1	5.64	5.29J	<0.5J	<80	14.4
37	Off-site	10510-11450	9/15/88	T0337	0-3	5.63	<20	<1	11.1	10.1	<0.5J	<80	32.8
18	Off-site	8250-8900	9/15/88	T0321	0-3	2.15	<20	<1	6.08	4.06J	<0.5J	<80	21.5
212	On-site	8470-9120	9/13/88	T0128	0-3	6.68	<20J	<1	11.3	15.1	<0.5J	<80	23.3
15	Off-site	7400-8890	9/12/88	T0078	0-3	9.63	<20	<1	6.26	8.79	<0.5J	<80	38.1
203	On-site	8700-8360	9/12/88	T0058	0-3	4.45	<20	<1	19.2	5.32J	<0.5J	<80	29.6
220	On-site	9570-9610	9/14/88	T0161	0-3	11.8	110	3.50	9.38	16.4	<0.5J	<80	30.1
221	On-site	8740-9750	9/14/88	T0153	0-3	11.6	25	3.32	8.29	24.2	<0.5J	<80	57.2
204	On-site	8930-8370	9/14/88	T0185	0-3	3.90	<20	<1	7.47	5.00J	<0.5J	<80	17.0
207	On-site	9040-8560	9/14/88	T0189	0-3	2.72	<20	<1	5.93	6.98J	<0.5J	<80	15.8
4	Off-site	10270-7440	9/16/88	T0363	0-3	3.03	<20	<1	10.5	4.34J	<0.5J	<80	22.0
217	On-site	9470-9400	8/17/89	I9425	18-24	2.78J	0.6J				<0.1J		
217 Dup	On-site	9470-94008	8/17/89	I9428	18-24	2.04J	<3.0J				<0.1J		

J - indicates that data is approximate.

NLI 002 0757

NL Industries, Inc. Site

<u>Ground Water Elevations</u>

Well ID	Screen Lengths FT	Top of Casing FT MSL	Well Depth FT	8/15/88 Water FT MSL	10/27/88 Water FT MSL	12/23/88 Water FT MSL	12/23/89 Water FT MSL	11/2/90 Water FT MSL	12/12/90 Water FT MSL
1R	28.00	15.26	32.00		6.00	6.75		6.49	6.85
2R2	7.00	11.08	22.10	3.84	3.44	4.42	[illegible]		3.59
3R	29.00	16.04	34.79	4.64	4.14	5.14	[illegible]	[illegible]	4.90
4R	12.00	16.74	23.89	5.25	4.64	5.55	5.37	4.89	5.28
5R	9.00	11.97	18.96	5.21	5.22	5.83	5.58	5.30	5.77
6	10.00	14.17	23.50		5.75	5.76	6.02	5.87	6.37
7	10.00	13.04	49.38	1.55	0.79	1.39	1.38	-3.24	2.02
8R	7.00	18.49	110.90		-13.51	-13.10	-13.90	-13.43	-6.94
9R2	8.00	18.67	67.70	-4.49	-6.13	-5.78	-6.12	-5.67	-3.48
10	30.00	15.66	72.42	-2.30	-3.49	-3.21	-3.50	-2.20	
10R	5.00	14.02	71.24					-3.84	-2.16
11	20.00	11.19	53.99	5.94	5.79	6.33	6.16	5.93	6.04
12	20.00	12.81	78.18	-2.05	-3.49	-3.02	-3.30	1.03	-1.97
13	20.00	11.59	110.00				-15.32	-14.75	-7.71
14	20.00	11.39	46.00				3.11	3.99	4.51
15	15.00	11.32	22.00				4.90	4.30	4.88
16	20.00	10.79	54.00				-0.68	-1.07	0.27
17	15.00	9.31	21.00				3.85	3.43	4.11
18	20.00	12.04	54.00				5.75	5.42	5.58
19	15.00	13.04	120.82					-18.45	-8.69
20	10.00	10.54	69.02					-4.34	-2.42
21	10.00	10.60	75.40					-1.76	-0.62
AR	30.00	13.33	35.00						
BR	6.00	10.82	38.85	5.78	5.47	5.99	5.78	5.52	5.66
CR2	6.00	17.90	33.55	5.37	3.62	4.64	4.60	4.02	3.88
HD	15.00	18.67	41.50	5.48	3.92	4.73	4.65	4.09	3.95
HS	15.00	18.77	26.44	5.48	3.87	4.71	4.65	4.07	3.93
ID	25.00	17.18	35.41	6.81	5.40	6.38	6.14	5.52	5.38
IS	10.00	17.35	15.50			8.71		7.67	7.71
JD	10.00	14.02	27.44	6.56	5.57	6.57	6.19	5.58	5.66
JS	10.00	13.89	17.00		5.54	6.53	6.15	5.55	5.61
KD	10.00	13.64	27.47	6.49	5.63	6.54	6.16	6.70	6.78
KS	10.00	12.45	17.78	6.56	2.70	6.61	6.25	5.77	5.93
LD	7.00	12.83	18.71	5.20	4.58	5.92	5.66	4.89	5.49
LS	7.00	12.68	13.05		4.93	6.29	6.08	5.32	5.98
MD	8.00	10.31	19.69	4.02	3.79	4.70	4.45	3.95	4.39
MS	7.00	11.77	12.11	5.34	3.82	4.72	4.49	4.21	4.69
ND	10.00	12.29	24.20	5.04	4.84	5.55	5.31	4.95	5.31
NS	10.00	13.24	16.85	4.89	4.86	5.66		5.07	5.45
OD	25.00	13.38	37.15	5.40	5.33	5.87	5.59	5.38	5.66
PD	10.00	12.86	29.75	6.43	6.09	6.62	6.40	6.18	6.31
PS	10.00	12.19	21.11		6.54	7.08	6.86	6.65	6.74
QD	10.00	11.08	22.95					4.60	
QS	10.00	12.13	15.73	5.64	5.43	6.21	5.82	5.57	[illegible]
RD	10.00	15.56	36.03	5.69	4.33	5.93	4.80	4.51	[illegible]
RS	15.00	15.78	22.00		7.33	8.04	7.93	7.50	7.78
SD	12.00	13.39	28.96	6.18	5.54	6.02		5.53	5.61
SS	10.00	12.70	16.77	6.46	5.59	6.35	6.10	5.76	5.76

Note: FT MSL represents feet above/below mean sea level

NLI 002 0758

Ta[illegible]-2 5/12/93

NL Industries, Inc. Site

Ground Water Quality Analyses - Numerical Wells

Sample ID	Well ID	Sample Date	Turbidity (NTU)	Filtered	Antimony (ppm)	Arsenic (ppm)	Cadmium (ppm)	Chromium (ppm)	Copper (ppm)	Lead (ppm)	Selenium (ppm)	TOC (ppm)	TOX (ppb)	SO4 (ppm)	Chloride (ppm)	pH	Conductivity (umho/cm)
I9180	1R	8/15/89	30	*	N/A	N/A	J0.003	N/A	N/A	J<0.005	N/A	N/A	N/A	2300	N/A	4.1	4400
T0012	2R2	8/17/88	>90	*	<0.03	R	J0.002	J0.008	<0.020	0.004	R	116	32.5	3340	150	6.6	5500
I9080	2R2	8/14/89	>90	*	N/A	J18.2	<0.010	N/A	N/A	J<0.001	N/A	N/A	N/A	5800	N/A	8.7	13000
J3684	2R2	11/14/89	N/A	*	N/A	4.9	0.01	N/A	N/A	<0.05	N/A	N/A	N/A	6100	N/A	N/A	9700
L4719	2R2	11/27/90	N/A	*		4.57	0.005	0.006		<0.005				2300		7.1	4200
T0009	3R	8/16/88	3	*	<0.03	<0.001	0.012	J0.002	<0.020	J0.01	<0.02	3	<10	147	<1	3.6	260
I9085	3R	8/14/89	18	*	N/A	N/A	J0.008	N/A	N/A	J0.007	N/A	N/A	N/A	770	N/A	3.1	270
T0007	4R	8/16/88	20	*	R<0.003	0.001	0.047	0.013	<0.020	0.031	<0.02	8	26.5	553	5	4.4	900
I9086	4R	8/14/89	4.8	*	N/A	N/A	J0.015	N/A	N/A	J0.011	N/A	N/A	N/A	190	N/A	3.6	650
T0008	5R	8/16/88	45	*	R<0.003	0.001	<0.001	0.012	<0.02	J0.01	<0.02	60	13	283	31	4.3	800
I9077	5R	8/14/89	>90	*	N/A	N/A	J0.001	N/A	N/A	J0.013	N/A	N/A	N/A	180	N/A	3.8	460
I9078	6	8/14/89	>90	*	N/A	N/A	J0.002	N/A	N/A	0.01	N/A	N/A	N/A	240	N/A	4.5	600
T0010	7	8/16/88	12	*	<0.03	<0.001	0.031	0.014	0.113	J0.008	<0.02	7	<10	647	7	4.2	1000
I9181	7	8/16/88	>90	*	N/A	N/A	0.023	N/A	J0.012	J<0.005	N/A	N/A	N/A	490	N/A	5.4	1200
T0032	9R2	8/18/88	45	*	J<0.003	<0.001	<0.001	J0.003	<0.020	J0.003	<0.002	3	<10	3	<1	4.7	80
I9380	9R2	8/15/89	N/A	*	N/A	N/A	<0.001	N/A	N/A	R	N/A	N/A	N/A	J2	N/A	5.0	100
L4713	9R2		N/A	*		0.0035	<0.003	<0.003		0.0014				<1		7.4	100
T0006	10	8/16/88	>90	*	<0.003	<0.001	0.045	0.010	0.028	0.012	<0.02	10	<10	284	5	4.9	550
I9381	10	8/17/89	N/A	*	N/A	N/A	0.041	N/A	N/A	R	N/A	N/A	N/A	J170	N/A	6.0	440
L4718	10R	11/26/90	N/A	*		0.003	<0.003	0.005		0.09				510		7.2	1100
T0003	11	8/15/88	53	*	<0.003	R	0.134	J0.005	0.042	J0.006	R	22	1750	2760	170	5.2	4500
I9256	11	8/16/89	N/A	*	N/A	<0.003	0.210	N/A	N/A	R	N/A	N/A	N/A	1800	N/A	5.7	4100
I9257	11	8/16/89	N/A	*	N/A	<0.003	0.213	N/A	N/A	J<0.005	N/A	N/A	N/A		N/A	N/A	N/A
T0011	12	8/16/88	13	*	<0.03	0.002	<0.001	J0.001	<0.020	J0.027	<0.002	1	<10	4	3	8.0	5.2
I9182	12	8/15/89	27	*	N/A	N/A	<0.001	N/A	N/A	R	N/A	N/A	N/A	<1	N/A	5.7	125
L4716	12	11/26/90	N/A	*		0.0023				0.0023				1		8.1	100
J2621	13	10/16/89	N/A	*	N/A	J<0.001	J<0.001	J0.003	N/A	R	N/A	N/A	N/A	3	N/A	6.0	75
L4723	13	11/27/90	N/A	*		0.0027	<0.003	<0.005		0.0023				<1		4.2	1000
J2622	14	10/16/89	N/A	*	N/A	J<0.001	J<0.001	R	N/A	R	N/A	N/A	N/A	30	N/A	5.2	115
L2664	14	10/31/90	N/A	*		0.002	0.003	0.005		0.0034				30		5.1	100
J2623	15	10/16/89	N/A	*	N/A	J<0.001	<0.001	R	N/A	R	N/A	N/A	N/A	22	N/A	5.2	110
L2662	15	10/30/90	8.7	*		0.002	<0.003	0.005		0.0021				15		4.7	100
J2619	16	10/17/89	N/A	*	N/A	J<0.001	J<0.001	R	N/A	R	N/A	N/A	N/A	31	N/A	7.0	125
L2665	16	10/31/90	N/A	*		0.002	<0.003	<0.005		0.002				27		5.6	100
J2620	17	10/17/89	N/A	*	N/A	0.006	<0.001	R	N/A	R	N/A	N/A	N/A	13	N/A	7.0	40
L2663	17	10/30/90	10	*		0.002	<0.003	<0.005		0.0026				10		5.1	100
L2661	18	10/30/90	2.6	*		<0.002	<0.003	<0.005		0.0061				59		4.6	300
L4711	19	11/26/90	N/A	*		0.0041	<0.003	<0.005		0.0045				4		8.9	100
L4715	20	11/26/90	N/A	*		0.004	<0.003	<0.005		0.0011				830		9.4	2100
L4712	21	11/27/90	N/A	*		0.003	<0.003	<0.005		0.001				51		9.0	400

NOTE: N/A – Not Analyzed

J – Indicates data considered approximate based on data validation

R – Indicates data rejected based on data validation

Table 2-3
NL Industries, Inc. Site
Ground Water Quality Analyses – Alphabetical Wells

Sample ID	Well ID	Sample Date	Turbidity (NTU)	Filtered	Antimony (ppm)	Arsenic (ppm)	Cadmium (ppm)	Chromium (ppm)	Copper (ppm)	Lead (ppm)	Selenium (ppm)	TOC (ppm)	TOX (ppb)	SO4 (ppm)	Chloride (ppm)	pH	Conductivity (umho/cm)
T0004	BR	8/16/88	1.5		<0.003	<0.001	0.015	J0.002	0.039	0.018	<0.02	6	<10	1100	59	5.7	2000
I9249	BR	8/16/88	N/A	*	N/A	N/A	J<0.001	N/A	N/A	J 0.005	N/A	N/A	N/A	J89	N/A	4.1	310
T0016	CR2	8/15/88	>90	*	<0.003	<0.001	<0.001	0.010	<0.020	J 0.028	<0.002	7	<10	4	<1	5.7	110
I9252	CR2	8/16/88	N/A	*	N/A	N/A	J<0.001	N/A	N/A	J 0.006	N/A	N/A	N/A	J3	N/A	5.7	130
T0040	HD	8/19/88	10	*	0.005	0.003	0.064	0.013	0.040	J 0.079	<0.02	9	27	1140	18	4.2	265
I9238	HD	8/16/88	>90	*	J<0.03	N/A	J0.379	N/A	N/A	J 0.009	N/A	N/A	N/A	J650	N/A	10.0	12,500
T0041	HS	8/19/88	>90	*	0.122	0.002	J0.010	J0.003	0.024	J 6.290	<0.002	12	15	84	3	3.8	300
I9237	HS	8/16/88	>90	*	J0.092	N/A	J0.0063	N/A	N/A	4.400	N/A	N/A	N/A	J69	N/A	4.4	220
T0025	ID	8/18/88	12	*	J<0.003	<0.001	0.004	0.001	<0.020	J 0.026	<0.02	1	<10	54	<1	3.4	170
I9241	ID	8/16/88	N/A	*	N/A	N/A	J0.003	N/A	N/A	J 0.011	N/A	N/A	N/A	J65	N/A	4.0	170
T0024	JD	8/15/88	44	*	<0.03	0.001	0.103	0.027	0.143	0.014	<0.02	8	15	741	5	4.0	510
I9242	JD	8/16/88	N/A	*	N/A	N/A	0.049	J0.009	J0.062	J 0.003	N/A	N/A	N/A	270	N/A	3.6	700
T0022	KD	8/18/88	>90	*	J<0.03	R	0.291	0.246	0.513	J 0.061	R	8	61	8460	110	2.5	12,000
I9245	KD	8/16/88	N/A	*	N/A	N/A	0.113	J0.081	J0.152	J 0.019	N/A	N/A	N/A	2700	N/A	3.4	500
L2660	KD	10/29/90	3.7			0.021	0.103	0.082		0.014				5700		3.2	1000
T0023	KS	8/18/88	>90	*	<0.03	R	0.173	0.060	0.219	3.130	R	28	27.5	3070	57	2.9	5000
I9243	KS	8/16/88	N/A	*	N/A	N/A	0.079	J0.016	J0.092	J 2.400	N/A	N/A	N/A	1300	N/A	4.2	N/A
I9244	KS	8/16/88	N/A	*	N/A	N/A	0.078	J0.015	J0.091	J 2.350	N/A	N/A	N/A	1300	N/A	N/A	N/A
T0013	LD	8/17/88	>5	*	<0.03	0.002	J0.002	0.011	<0.020	0.044	<0.02	18	<10	170	<1	4.0	340
I9083	LD	8/14/89	2.7		N/A	N/A	0.002	N/A	N/A	J 0.024	N/A	N/A	N/A	41	N/A	3.5	120
T0028	MD	8/18/88	>90	*	<0.003	R	0.008	J0.005	<0.020	0.002	R	23	99.5	1730	140	5.7	4000
I9081	MD	8/14/89	>90	*	N/A	J<0.001	J0.008	N/A	N/A	J 0.005	N/A	N/A	N/A	570	N/A	4.9	1400
L2657	MD	10/30/90	48			J0.003	0.005	<0.005		0.001				1400		5.2	2800
T0029	MS	8/18/88	46	*	J<0.003	<0.001	0.011	J0.004	<0.020	J 0.198	<0.02	14	29	321	5	4.0	700
I9079	MS	8/14/89	22	*	N/A	N/A	J0.016	N/A	N/A	J 0.219	N/A	N/A	N/A	N/A	N/A	4.1	700
T0034	ND	8/19/88	22	*	<0.03	0.001	J0.008	0.012	0.068	J 0.064	<0.02	38	58	1580	45	3.4	270
I9076	ND	8/14/89	>90	*	N/A	N/A	0.006	N/A	N/A	J 0.014	N/A	N/A	N/A	2000	N/A	3.8	3400
T0037	NS	8/19/88	19	*	<0.03	<0.001	0.009	0.013	<0.020	J 0.045	<0.02	15	97.5	367	3	3.6	710
I9075	NS	8/14/89	>90	*	N/A	N/A	0.004	N/A	N/A	J 0.01	N/A	N/A	N/A	200	N/A	3.9	4800
T0036	OD	8/17/88	49	*	<0.03	0.002	J0.002	0.045	<0.020	0.030	<0.02	56	46	5630	48	4.0	10,000
I9239	OD	8/16/89	N/A	*	N/A	N/A	J<0.001	J0.121	N/A	J 0.003	N/A	N/A	N/A	980	N/A	4.1	2000
T0001	PD	8/15/88	20	*	J<0.003	0.017	J0.001	J0.002	<0.020	J 0.039	<0.02	11	81.5	1140	100	5.6	2300
I9240	PD	8/16/89	<5		N/A	0.003	J0.001	N/A	N/A	J 0.009	N/A	N/A	N/A	J740	N/A	5.7	1600
T0035	QS	8/19/88	26	*	<0.003	0.002	0.007	J0.003	<0.020	0.090	<0.002	54	40	328	<1	4.2	335
T0026	RD	8/17/88	>90	*	<0.003	<0.001	<0.001	J0.003	<0.020	J 0.004	0.004	4	<10	46	6	5.0	200
I9247	RD	8/16/89	N/A	*	N/A	N/A	J<0.001	N/A	N/A	J 0.001	N/A	N/A	N/A	J32	N/A	5.9	240
I9246	RS	8/16/89	N/A	*	N/A	N/A	J<0.001	N/A	N/A	J 0.002	N/A	N/A	N/A	J12	N/A	6.1	170
T0038	SD	8/19/88	>90	*	<0.03	<0.01	1.01	3.250	3.84	0.294	R	N/A	235	N/A	N/A	3.7	20,000
I9250	SD	8/16/89	N/A	*	N/A	R	0.963	J4.340	J4.680	J 0.084	N/A	N/A	N/A	24000	N/A	2.3	24,000
I9251	SD	8/16/89	N/A	*	N/A	N/A	0.899	J4.030	J4.360	J 0.06	N/A	N/A	N/A	24000	N/A	N/A	N/A
L2656	SD	10/30/90	>90	*	N/A	0.029	0.997	3.66		0.056				25000		2.5	10,000
T0039	SS	8/19/88	81	*	<0.03	0.020	0.119	0.021	0.011	J 0.086	<0.02	91	73	1090	92	4.1	3800
I9248	SS	8/16/89	N/A	*	N/A	0.005	J0.015	J0.010	N/A	R	N/A	N/A	N/A	940	N/A	5.4	1800

NOTE: N/A – Not Analyzed

R – Indicates data rejected based on data validation, J – Indicates results should be considered approximate

NL Industries, Inc. Site

Ground Water Analyses - Radiologic Indicators - Numerical Wells

Sample ID	Well ID	Filtered	Date	Gross Alpha	Gross Beta	Total Radium
T0012	2R2	X	8/17/88	<20.0	<90.0	
T5566	2R2	X	8/14/89	<70.0	<100.0	
21471	2R2	X	11/27/90	<10	23 +/- 11	
T0009	3R		8/16/88	<4.0	9.0 +/- 3.5	
T0007	4R	X	8/18/88	<3.0	13.0 +/- 8.0	
T0008	5R	X	8/16/88	<4.0	<20.0	
T0010	7	X	8/16/88	<6.0	<20.0	
T5556	7	X	8/15/89	<3.0		3.6 +/- 2.1
T0032	9R2	X	8/18/88	<0.9	<2.0	
T0006	10	X	8/16/88	<4.0	<10.0	
21470	10R	X	11/16/90	<4.0	9.8 +/- 1.5	
T0003	11	X	8/15/88	<10.0	<50.0	
T5573	11	X	8/16/89	<40.0		61.0 +/- 7.0
75574	11-DUP	X	8/16/89			67.0 +/- 8.0
T0011	12	X	8/18/88	<2.0	2.6 +/- 1.6	
81170	13	X	10/16/89	<1.0	1.3 +/- 0.2	
81171	14	X	10/16/89	<1.0	6.2 +/- 1.4	
81172	15	X	10/16/89	<1.0	4.5 +/- 1.3	
81169	16	X	10/17/89	<1.0	4.9 +/- 1.4	
81168	17	X	10/17/89	1.0 +/- 0.4	2.1 +/- 0.4	
21469	20	X	11/26/90	<2.0	49 +/- 2	
21472	21	X	11/27/90	<5.0	240 +/- 10	
T0020	PW2		8/17/88	<3.0	<4.0	
T0018	PW3		8/17/88	<1.0	3.1 +/- 1.4	
T0019	PW3		8/17/88	1.6 +/- 1.3	3.4 +/- 1.7	
T0014	PW4		8/17/88	<1.0	<2.0	
T0015	PW6		8/17/88	<1.0	6.5 +/- 1.7	
T0031	PW7		8/18/88	<1.0	4.8 +/- 1/6	
T0030	PW9		8/18/88	<5.0	3.9 +/- 7.0	
81173	RINSE BLANK		10/17/89	<7.0	1.8 +/- 1.0	

NOTE: Units in pCi/l

+/- = Represents the uncertainty of the value determined

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NL Industries, Inc. Site

Ground Water Analyses - Radiologic Indicators - Alphabetical Wells

Sample ID	Well ID	Filtered	Date	Gross Alpha	Gross Beta	Total Radium
T0004	BR		8/17/88	<8.0	<[illegible].0	
75562	BR	X	8/16/89	3.6 +/- 1.2		3.8 +[illegible]3
T0016	CR2	X	8/17/88	<1.0	[illegible]	
T0040	HD	X	8/18/88	<7.0	<[illegible].0	
75570	HD	X	8/16/89	17.0 +/- 12.0		30.0 +/- [illegible].0
T0041	HS	X	8/19/88	<3.0	9.3 +/- [illegible].0	
T0025	ID	X	8/18/88	<1.0	7.1 +/- 1.9	
T0024	JD	X	8/18/88	<8.0	<20.0	
75569	JD	X	8/16/89	<4.0		6.3 +/- 2.6
T0022	KD	X	8/18/88	43.0 +/- 26.0	<100.0	
75575	KD	X	8/16/89	<60.0	<100.0	
18994	KD	X	10/29/90	57 +/- 21	<20	
T0023	KS	X	8/18/88	<10.0	<60.0	
75577	KS	X	8/16/89	<20.0	<40.0	
75576	KS	X	8/16/89	<30.0	<60.0	
T0013	LD	X	8/17/88	<4.0	7.6 +/- 3.7	
T0028	MD	X	8/18/88	<10.0	<50.0	
75555	MD	X	8/14/89	<5.0		<2.0
T0029	MS	X	8/18/88	<4.0	<9.0	
T0034	ND	X	8/19/88	8.5 +/- 4.9	27.0 +/- 11.0	
T0037	NS	X	8/19/88	<3.0	<10.0	
T0036	OD	X	8/19/88	<20.0	<40.0	
75557	OD	X	8/16/89	<40.0		100.0 +/- 10.0
T0001	PD	X	8/15/88	<20.0	44.0 +/- 29.0	
75571	PD		8/16/89	<7.0		10.0 +/- 3.0
T0035	QS	X	8/19/88	<3.0	6.0 +/- 2.9	
T0026	RD	X	8/18/88	<3.0	7.7 +/- 2.8	
T0038	SD	X	8/19/88	260. +/- 110.	420. +/- 210.	
75564	SD	X	8/16/89	570.0 +/- 180	580.0 +/- 170.0	
75565	SD	X	8/16/89	530.0 +/- 180	700.0 +/- 180	
18998	SD	X	10/30/90	13 +/- 10	21 +/- 5	
T0039	SS	X	8/19/88	<20.0	<40.0	
75567	SS	X	8/16/89	<20.0		7.0 +/- 2.6
75568	SS-DUP	X	8/16/89			6.6 +/- 2.6
T0005	BR(RB)		8/16/89	<2.0	4.0 +/- 2.4	
T0021	KD(RB)		8/18/88	<3.0	<4.0	
T0033	ND(RB)	X	8/19/88	<5.0	<5.0	
T0002	PD(RB)	X	8/15/88	3.0	3.7 +/- 2.5	
81173	RB		10/17/89	<7.0	1.8 +/- 1.0	
18999	Fld. Blnk		10/30/90	<0.9	<2.0	

NOTES:
Units in pCi/l
(RB) = Rinse Blank
+/- = Represents the uncertainty of the value determined
DUP = Duplicate sample

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Table 2-6

NL Industries, Inc. Site

Suspended Solids Analyses* - Specific Radionuclides

Well ID: Sample Date	2R2 11/27/90	KD 10/29/90	SD 10/30/90
RA-226	<1	<1	1.3 +/- 0.5
K-40	<40	<0.4	15 +/- 2
PB-210	<20	<6	14 +/- 9
U-234	<0.8	--	--
U-235	<0.4	<0.7	<2
U-238	<0.7	4.2 +/- 1.7	<3
TH-230	<3	--	--
TH-232	<3	<0.9	11 +/- 2
TH-228	8.5 +/- 3.9	<3	12 +/- 3

Legend:

* = Solid phase retained from filtering ground water through a 0.45 um filter.

-- = Not analyzed

NL Industries, Inc. Site

Ground Water Analyses - Specific Radionuclides

Well ID:	2R2	2R2	2R2	KS	KS	KD	KD	RD	SD	SD	SD
Sample Date:	8/17/88	8/14/89	11/27/90	8/16/89	8/16/89	8/16/89	10/29/90	8/18/88	8/16/89	8/16/89	10/30/90
GR-A	<20.0	<70	<10	<20	<30.0	<60	57 +/- 21	<3	570 +/- 180	530.0 +/- 180	13 +/- 10
GR-B	<90.0	<100	23 +/- 10	<40	<60.0	<100	<20	7.7 +/- 2.8	580 +/- 170	700.0 +/- 180	21 +/- 5
PB-210	<10.0	<5	<4.0	<5	<4.0	<5	<20	<10	5.6 +/- 3.8	8.5 +/- 3.6	<10
RA-226	<0.1	<1	<1.0	<1	<1.0	<1	<1.0	<0.1	<1	<1.0	
RA-228	1.0 +/- 0.6	<1		1.7 +/- 0.5	1.3 +/- 0.5	1.8 +/- 0.6		<0.8	<80	<0.8	
BE-7		<40		<30	<40.0	<50.0			<40	<50.0	
K-40	14.0 +/- 1.0	<90	10 +/- 0.1	<60	<60.0	<40.0	10 +/- 1	5.3 +/- 0.1	60.6 +/- 32.5	<90.0	10 +/- 1
MN-54		<4		<3	<3.0	<3.0			<3	<4.0	
CO-58		<4		<3	<3.0	<4.0			<4	<5.0	
FE-59		<10		<8	<8.0	<10.0			<10	<10.0	
CO-60		<4		<3	<4.0	<3.0			<4	<5.0	
ZN-65		<9		<7	<7.0	<7.0			<8	<9.0	
ZR-95		<5		<4	<4.0	<5.0			<4	<5.0	
RU-103		<6		<4	<5.0	<7.0			<5	<7.0	
RU-106		<30		<30	<30.0	<30.0			<30	<40.0	
I-131		<40		<20	<30.0	<200.0			<30	<40.0	
CS-134		<4		<3	<3.0	<3.0			<3	<5.0	
CS-137		<4		<3	<4.0	<3.0			<4	<5.0	
BA-140		<20		<20	<20.0	<50.0			<10	<20.0	
CE-141		<10		<10	<10.0	<10.0			<10	<10.0	
CE-144		<40		<30	<30.0	<20.0			<30	<40.0	
TH-228	1.3 +/- 0.4	<20	<50	<6	<6.0	<5.0	3.2 +/- 1.4	<2.0	70.2 +/- 7.0	29.0 +/- 13.0	130 +/- 10
U-234	3.4 +/- 0.5	24.0 +/- 4.0	9.5 +/- 1.1	1.3 +/- 0.2	1.5 +/- 0.4	2.3 +/- 0.3		<0.2	98.0 +/-40.0	100.0 +/- 10.0	
TH-230	.48 +/- 0.29	38.0 +/- 14.0	<10	28.0 +/- 3.0	44.0 +/- 9.0	44.0 +/- 11.0		1.1 +/- 0.7	84.0 +/- 15.0	74.0 +/- 17.0	
TH-232	<.07	180.0 +/- 30.0	<10	<0.3	16.0 +/- 7.0	<4.0	1.4 +/- 0.9	.72 +/- 0.57	69.0 +/- 14.0	100.0 +/- 20.0	150 +/- 10
U-235	.14 +/- 0.1	<1.0	47 +/- 26	<0.1	<0.3	<0.1	0.06	<0.8	3.6 +/- 0.7	4.3 +/- 0.6	4 +/- 0.5
U-238	3.2 +/- .04	22.0 +/- 4.0	10 +/- 1	1.1 +/- 0.2	1.1 +/- 0.4	2.1 +/- 0.3	1.2 +/- 0.2	<0.1	100.0 +/- 10.0	100.0 +/- 10.0	110 +/- 10

Note: Units in pCi/l

+/- = Represents the uncertainty of the value determined

TABLE 2-8 5/12/93

NL Industries, Inc. Site

Ground Water Quality - Organic Analysis Summary

	latile Organics			Semi-Volatile	Pest./PCBs
Well ID	502/503 (1989)	601/602 (1990)	8240 (1990)	8270 (1990)	8080 (1990)
2R2	ND	NA	D	ND	ND
9R2	NA	NA	ND	ND	ND
10R	NA	NA	ND	ND	ND
11	D	D	D	ND	ND
12	NA	NA	ND	ND	ND
13	NA	D	NA	NA	NA
18	NA	D	NA	NA	NA
19	NA	NA	ND	ND	ND
20	NA	NA	D	ND	ND
21	NA	NA	ND	ND	ND
BR	NA	D	NA	NA	NA
KD	NA	ND	NA	NA	NA
MD	ND	ND	ND	ND	ND
OD	NA	ND	NA	NA	NA
OS	NA	ND	NA	NA	NA
DS	NA	ND	NA	NA	NA
SS	NA	ND	NA	NA	NA
SD	D	D	D	D	ND

(1) EPA Analytical Method Identified

D At least one parameter above method detection limit for this well, see Table V-12.

NA Not analyzed using this protocol.

ND No parameter tested by this method above method detection limit.

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Table 2-9

NL Industries, Inc. Site

Ground Water Quality - Detected Organics

	Monitoring Wells									
	2R2		11		13	18	20	BR	SD	
Parameter	(1989)	(1990)	(1989)	(1990)	(1990)	(1990)	(1990)	(1989)	(1989)	(1990)
Acetone	--	14	--	50u	--	--	12	--	--	10u
1,1,1-Trichloroethane	2.5u	21	4700	2500	0.5u	0.5u	5u	5u	0.5u	0.5u
1,1-Dichloroethene	2.5u	5u	170	210	0.5u	0.5u	5u	5u	0.5u	0.5u
Chloroform	2.5u	5u	50u	25u	0.5u	0.5u	5u	5u	2.7	7
1,2-Dibromomethane	2.5u	--	50u	50u	2J	0.5u	--	5u	0.5u	0.5u
Vinyl Chloride	2.5u	10u	50u	50u	0.5u	0.5u	10u	76	0.5u	0.5u
Toluene	2.5u	5u	5u	5u	0.5u	0.5u	5u	1.4	1.3	1.8
Ethylbenzene	2.5u	5u	5u	5u	0.5u	0.5u	5u	0.5	0.5	0.6
m-Xylene	2.5u	5u	5u	5u	0.5u	0.5u	5u	4.0	0.9	2.3
o-Xylene	2.5u	5u	5u	5u	0.5u	0.5u	5u	1.6	0.6	0.8
1,3,5-Trimethylbenzene	2.5u	--	5u	5u	0.5u	0.5u	--	0.8	0.5u	1.0u
1,2,4-Trimethylbenzene	2.5u	10u	5u	5u	0.5u	0.5u	10u	2.7	0.5u	0.5
Napthalene	2.5u	10u	5u	5u	0.5u	0.5u	10u	2.3	0.5u	1.0u
1,1-Dichloroethane	2.5u	5u	74	54	0.5u	0.5u	5u	5u	0.5u	0.5u
Tetrachloroethene	2.5u	5u	180	210	0.5u	0.5u	5u	5u	0.5u	0.5u
1,2-Dichloropropane	2.5u	5u	50u	50u	0.5u	0.5	5u	5u	0.5u	0.5u
N-Nitroso-di-n-propylamine	--	10u	--	10u	--	--	10u	--	--	11
Bis(2-ethylhexyl)phthalate	--	10u	--	10u	--	--	10u	--	--	13

Note:

Units are in ppb.

Table 2-10 5/12/93

NL Industries, Inc. Site

Ground Water Quality - Inorganic Priority Pollutant Analyses

Well ID:	11	11	11-DUP	JD	JD	ID	SD	SD	SD-DUP	QS	
Description:	T0003	I9256	I9257	T0024	I9242	T0025	T0038	I9250	I9251	T0035	Blank
Date:	8/15/88	8/16/89	8/16/89	8/18/88	8/16/89	8/18/88	8/19/88	8/16/89	8/16/89	8/19/88	8/17/88
Silver	<0.01			<0.01		<0.01	0.044	0.037	0.034	<0.01	<0.01
Arsenic	R			0.001		<0.001	R			0.002	0.002
Beryllium	0.003			0.007		0.003	0.156			0.003	0.003
Cadmium	0.134			0.103		0.004	1.01			0.007	0.001
Chromium	0.005J			0.027		0.001J	3.25			0.003J	0.01
Copper	0.042			0.143		<0.02	3.84			<0.02	<0.02
Mercury	<0.0002			<0.0002		0.0006	0.0003			<0.0002	<0.0002
Nickel	0.063	0.14J	0.139J	0.099	0.064J	<0.04	1.93	2.48	2.31	<0.04	<0.04
Lead	0.006J			0.014		0.026J	0.294			0.090	0.001
Antimony	<0.003			<0.03		<0.003J	<0.03			<0.003	<0.03
Selenium	R			<0.02		<0.02	R			<0.002	<0.002
Zinc	0.297			0.603		0.088	8.64	9.69	9.11	0.018	<0.01
Cyanide	N/A			<0.01		N/A	<0.01			<0.01	<0.01
Thallium	0.001			<0.001		<0.001	0.003			<0.001	<0.001

Note:

J - Indicates data considered appropriate based on data validation

R - Indicates data rejected based on data validation

N/A - Not Analyzed

Units are in ppm.

NLI 002 0767

NL Industries, Inc. Site

Ground Water Quality Analyses

Sample ID	Well ID	Sample Date	Turbidity (NTU)	Filtered	Antimony (ppm)	Arsenic (ppm)	Cadmium (ppm)	Chromium (ppm)	Copper (ppm)		Lead (ppm)	Selenium (ppm)	TOC (ppm)	TOX (ppb)	SO4 (ppm)	Chloride (ppm)	pH	Conductivity (umho/cm)
T0020	PW2	8/17/88	N/A		<0.003	<0.001	J<0.001	0.011	<0.020	J	0.022	<0.002	5	<10	27	43	6.0	210
I9187	PW2	8/15/89	N/A		N/A	N/A	<0.001	N/A	N/A	J	<0.001	N/A	N/A	N/A	N/A	N/A	5.7	N/A
T0018	PW3	8/17/88	N/A		<0.003	0.002	J<0.001	J0.009	J0.253	J	0.117	<0.002	<1	N/A	4	12	5.5	135
I9184	PW3	8/15/89	N/A		N/A	N/A	<0.001	N/A	N/A	J	0.001	N/A	N/A	N/A	N/A	N/A	5.8	N/A
T0019	PW3-DUP	8/17/88	N/A		<0.003	0.003	J<0.001	J0.005	J0.056	J	0.006	<0.002	4	<10	6	11	N/A	N/A
T0014	PW4	8/17/88	N/A		<0.003	0.006	<0.001	0.013	<0.020	J	0.002	<0.002	5	<10	9.8	9	5.5	140
I9178	PW4	8/15/89	N/A		N/A	N/A	<0.001	N/A	N/A	J	<0.001	N/A	N/A	N/A	N/A	N/A	5.9	N/A
I9179	PW5	8/15/89	N/A		N/A	N/A	<0.001	N/A	N/A	J	<0.001	N/A	N/A	N/A	N/A	N/A	6.1	N/A
T0015	PW6	8/17/88	N/A		<0.003	<0.001	J<0.001	0.012	0.057	J	0.008	<0.02	2	<10	27	15	5.4	170
I9253	PW6	8/16/89	N/A		N/A	N/A	J<0.001	N/A	N/A	J	0.013	N/A	N/A	N/A	N/A	N/A	4.9	N/A
T0031	PW7	8/18/88	N/A		<0.003	0.003	J<0.001	J0.007	<0.020	J	0.005	<0.02	5	<10	35	25	4.8	235
I9255	PW7	8/16/89	N/A		N/A	N/A	<0.001	N/A	N/A	J	0.010	N/A	N/A	N/A	N/A	N/A	5.1	N/A
I9185	PW8	8/15/89	N/A		N/A	N/A	<0.001	N/A	N/A	J	<0.001	N/A	N/A	N/A	N/A	N/A	6.6	N/A
T0030	PW9	8/18/88	N/A		<0.003	0.002	J0.003	0.011	0.045	J	0.004	<0.002	3	20.5	85	49	4.7	600
I9082	PW9	8/14/89	N/A		N/A	N/A	0.002	N/A	N/A	J	<0.001	N/A	N/A	N/A	N/A	N/A	5.0	N/A

NOTE: N/A - Not Analyzed

RB - Rinse Blank

DUP - Duplicate Sample

R - Indicates data rejected based on data validation

J - Indicates results should be considered approximate

Table 3
NL Industries, Inc. Site
Surface Water Quality Analyses

Sample ID	Location ID	Sample Date	Lead (ppm)	Antimony (ppm)	Arsenic (ppm)	Cadmium (ppm)	Chromium (ppm)	Copper (ppm)	Cyanide (ppm)	Zinc (ppm)	Tin (ppm)	Sulfate (ppm)	Hardness (ppm as CaCO3)	Chloride (ppm)	pH	Conductivity (umhos/cm)	Flow State
L25714	EPA1	12/11/90	0.012	<0.05	0.0037	<0.003	<0.005	0.017		0.223			210				
L21390	EPA2	12/11/90	0.068	<0.05	0.0034	<0.003	<0.005	0.017	<0.01	0.088		130	69				
L25715	EPA3	12/11/90	0.027	<0.05	0.004	<0.003	<0.005	0.01		0.19			170				
L25716	EPA4	12/11/90	0.024	<0.05	0.003	<0.003	<0.005	0.017		0.159			160				
L25717	EPA5	12/11/90	0.029	<0.05	0.0039	<0.003	<0.005	0.027		0.077			73				
L25718	EPA6	12/10/90	0.007	<0.05	0.0028	<0.003	<0.005	0.013		0.137			62				
L25719	EPA7	12/10/90	0.016	<0.05	0.0043	<0.003	<0.005	0.019		0.086			100				
L25720	EPA8	12/10/90	0.012	<0.05	0.0037	<0.003	<0.005	0.008		0.139			180				
L25721	EPA9	12/10/90	0.011	<0.05	0.0032	<0.003	<0.005	<0.005		0.197			280				
L25722	EPA10	12/10/90	0.009	<0.05	0.0049	<0.003	<0.005	0.009		0.161			240				
L25723	EPA11	12/10/90	0.009	<0.05	0.0045	<0.003	<0.005	0.01		0.156			240				
L25724	EPA12	12/11/90	0.004	<0.05	0.0022	<0.003	<0.005	0.007		0.069			56				
L25725	EPA13	12/12/90	0.206	<0.05	0.0029	<0.003	<0.005	0.017		0.106			55				
J2611	ES-1	10/17/89	J.010									600		230	7.2	2200	
J2612	ES-2	10/17/89	R									100		55	7.3	450	
J2618	ES-3	10/17/89	R									57		<25	7.4	120	
J2617	ES-4	10/17/89	R									73		<25	7.2	120	
J2615	ES-5	10/17/89	R									30		<25	7.2	260	
J2609	ES-6	10/17/89	0.101									19		<25	7.3	110	
J2606	WS-1	10/16/89	J.049									170		<25	7	430	
J2607	WS-2	10/16/89	J.069									170		<25	7.1	415	
J2608	WS-3	10/16/89	J.085									180		<25	7.2	420	
J2602	WS-4	10/16/89	J.084									170		<25	7.1	520	
J2601	WS-5	10/16/89	0.313									230		<25	7	680	
J2604	WS-6	10/16/89	J.078									240		<25	7	700	
J2603	WS-7	10/16/89	0.408									1200		<25	6.7	3200	
J2600	WS-8	10/16/89	0.414									740		<25	6.6	900	
J2597	WS-9	10/16/89	1.27	J.079	0.06	0.014	0.016	0.039	J<.010	0.162	<.800	460		<25	6.6	1200	
J2605	WS-11	10/16/89	0.19									34		<25	6.9	220	
J2624	WS-12	10/17/89	J2.200									9		<25	7.2	130	
J2610	WS-16	10/17/89	0.244									140		<25	7.2	340	
J2616	WS-17	10/17/89	J.418									140		<25	7.4	360	
T0043	401	8/19/88	0.098												6		low
T0043	401	8/19/88	0.114												N/A		low
T0044	402	8/19/88	1.24												4		low
T0045	403	8/19/88	0.263												4		low
T0046	405	8/19/88	0.025												5.5		low
T0047	406	8/19/88	0.011												6		low
T0138	401	9/13/88	0.1												5.3		high
T0124	402	9/13/88	1.06												3.4		high
T0136	403	9/13/88	0.088												3.3		high
T0126	404	9/13/88	2.18												3		high
T0134	405	9/13/88	0.021												3.6		high
T0132	406	9/13/88	0.0117												6.4		high
T0103	408	9/13/88	3												3.5		high
T0101	409	9/13/88	1.98												3.4		high
T0099	411	9/13/88	0.0232												4.3		high

Note: Sample EPA2 was analyzed for organic compounds by EPA Methods 8080, 8240, 8270 and for Phenolics.
All of the constituents that could be detected by these methods were found to be below method detection limits.

R = Indicates data rejected based on data validation
J = Indicates results should be considered approximate
N/A = Not analyzed

Table 4-1 5/12/93

NL Industries, Inc. Site

Surface Water Sediment Sample Analyses (400 Series)

Sample ID	Location ID	Sa[illegible]	Sample Type	Lead (ppm)
T0139	401	9-[illegible]-88	sediment	817
T0125	402	9-[illegible]-88	sediment	1640
T0137	403	9-13-88	sediment	3060
T0127	404	9-13-88	sediment	702
T0135	405	9-13-88	sediment	4350
T0133	406	9-13-88	sediment	<5
T0102	408	9-13-88	sediment	286
T0100	409	9-13-88	sediment	552
T0098	411	9-13-88	sediment	77.5

NL Industries, Inc. Site

Surface Water Sediment Sample Analyses (ES Locations)

Sample ID	Location	Date	Lead (ppm)
J3043	ES-1 (0-3)	10/17/89	13.9
J3046	(3-6)	10/17/89	21.8
J3047	(6-8)	10/17/89	28.2
J3043	ES-2 (0-3)	10/17/89	251.0
J3044	(3-4)	10/17/89	49.4
J3061	ES-3 (0-3)	10/17/89	22.8
J3062	(3-6)	10/17/89	20.8
J3066	ES-4 (0-3)	10/17/89	536.0
J3067	(3-6)	10/17/89	44.4
J3068	(6-8)	10/17/89	J38.3
J3060	ES-5 (0-3)	10/17/89	J206.0
J3063	ES-6 (0-3)	10/17/89	36.9
J3064	(3-6)	10/17/89	73.0
J3065	(6-10)	10/17/89	159.0
J3080	ES-7 (0-3)	10/17/89	J628.0
J3081	(3-6)	10/17/89	J177.0
J3082	(6-11)	10/17/89	J39.7
L5993	ES-10 (0-6)	11/1/90	192
L5994	(6-12)	11/1/90	15
L5995	ES-11 (0-6)	11/1/90	57.3
L5996	(6-12)	11/1/90	4.51
L5997	ES-12 (0-6)	11/1/90	4.99
L5998	ES-13 (0-6)	11/1/90	2.27
L5999	(6-12)	11/1/90	1.31
L6000	ES-14 (0-6)	11/1/90	151
L6001	(6-12)	11/1/90	218
L6002	ES-15 (0-6)	11/1/90	24.6
L6003	(6-12)	11/1/90	25.9
L6004	ES-16 (0-6)	11/1/90	249
L6005	(6-12)	11/1/90	16.2
J3069	DUP ES-2 (0-3)	10/17/89	J35.4
J3070	DUP ES-2 (3-5)	10/17/89	J15.3

Note: J indicates that data is considered approximate.

Table 4-3 5/12/93

NL Industries, Inc. Site
Surface Water Sediment Sample Analyses (WS Locations)

Sample ID	Location	Date	Lead (ppm)
J3039	WS-1 (0-3)	10/16/89	J1350.0
J3040	(3-6)	10/16/89	J551.0
J3041	(6-12)	10/16/89	J225.0
J3042	(12-20)	10/16/89	J14.6
J3032	WS-2 (0-3)	10/16/89	J2800.0
J3033	(3-6)	10/16/89	J542.0
J3034	(6-12)	10/16/89	J180.0
J3035	(12-15)	10/16/89	J357.0
J3091	WS-3 (0-3)	10/16/89	J816.0
J3092	(3-6)	10/16/89	J2220.0
J3093	(6-12)	10/16/89	J329.0
J3094	(12-15)	10/16/89	108.0
J3051	WS-4 (0-3)	10/17/89	J1970.0
J3052	(3-6)	10/17/89	J1570.0
J3053	(6-12)	10/17/89	J400.0
J3054	(12-18)	10/17/89	J72.4
J3025	WS-5 (0-3)	10/16/89	J1350.0
J3026	(3-6)	10/16/89	J1000.0
J3027	(6-12)	10/16/89	J72.5
J3028	(12-14)	10/16/89	18.5
J3059	WS-6 (0-3)	10/17/89	J897.0
J3074	WS-7 (0-3)	10/16/89	J1870.0
J3075	(3-6)	10/17/89	J5540.0
J3076	(6-12)	10/17/89	J235.0
J3077	(12-19)	10/17/89	J8.6
J3036	WS-8 (0-3)	10/16/89	J1310.0
J3037	(3-6)	10/16/89	490.0
J3038	(6-9)	10/16/89	19.6
L6006	WS-8 (0-6)	11/1/90	2180
J3029	WS-9 (0-3)	10/16/89	J6403.9
J3030	(3-6)	10/16/89	899.1
J3031	(6-9)	10/16/89	28.9
L6008	WS-9 (0-6)	12/12/90	699
L6010	(6-12)	12/12/90	4.12
J3055	WS-10 (0-3)	10/17/89	J2470.0
J3056	(3-6)	10/17/89	J247.0
J3057	(6-12)	10/17/89	J61.5
J3058	(12-20)	10/17/89	J13.9
J3098	WS-11 (0-3)	10/16/89	J23700.0
J3099	(3-6)	10/16/89	59700.0
J3100	(6-10)	10/16/89	702.0
L6012	WS-11 (0-6)	11/1/90	22400
L6014	(6-12)	11/1/90	532
J3048	WS-12 (0-3)	10/17/89	J1860.0
J3049	(3-6)	10/17/89	589.0
J3050	(6-10)	10/17/89	140.0

Note: J indicates that data is considered approximate

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Table 4-3 5/12/93
(Continued)

NL Industries, Inc. Site
Surface Water Sediment Sample Analyses (WS Locations)

Sample ID	Location		Date	Lead (ppm)
J3083	WS-13	(0-3)	10/17/89	J171.0
J3084		(3-6)	10/17/89	J50.0
J3085		(6-12)	10/17/89	J31.0
J3086		(12-16)	10/17/89	J9.6
L6016	WS-13	(0-6)	11/1/90	134
L6017		(6-12)	11/1/90	10.3
L6017		(12-18)	11/1/90	2.45
J3087	WS-14	(0-3)	10/17/89	J275.0
J3088		(3-6)	10/17/89	2870
J3089		(6-12)	10/17/89	145
J3090		(12-17)	10/17/89	8.7
J3071	WS-15	(0-3)	10/17/89	J246.0
J3072		(3-6)	10/17/89	J1380.0
J3073		(6-8)	10/17/89	J250.0
L6019	WS-15	(0-6)	11/1/90	867
L6020		(6-12)	11/1/90	4240
J3078	WS-16	(0-3)	10/17/89	J1590.0
J3079		(3-5)	10/17/89	J1600.0
L6021	WS-16	(0-6)	11/1/90	642
L5969		(6-12)	11/1/90	558
J3095	WS-17	(0-3)	10/16/89	J1890.0
J3096		(3-6)	10/16/89	110
J3097		(6-9)	10/16/89	33.7

NL Industries, Inc. Site

Surface Water Sediment Sample Analyses (EPA Locations)

Sample ID	Sample Date	Laboratory Number	Sample Depth(in.)	Antimony (ppm)	Arsenic (ppm)	Cadmium (ppm)	Chromium (ppm)	Copper (ppm)	Lead (ppm)	Selenium (ppm)	Zinc (ppm)	TOC % w/w	pH S.U.
EPA1	12-11-90	L5970	0-6	<29.4	34.0	3.01		25.5	101	<1.76	471	3.95	6.6
	12-11-90	L5971	6-12	20.0	35.5	10.0	57.6	42.8	587	<0.909	553	0.25	6.7
EPA2	12-11-90	L5972	0-6	44.8	63.3	9.13	46.0	74.8	1340	<2.50	236	23.50	6.0
	12-11-90	L5973	6-12	<29.4	31.1	6.27	35.9	34.9	767	<1.76	143	13.78	5.9
EPA3	12-11-90	L5974	0-6	<15.6	15.7	11.7	34.9	43.0	672	<0.938	464	7.10	6.9
EPA4	12-11-90	L5975	0-6	54.3	90.8	63.3	145	160	2870	2.38	1920	13.15	7.1
	12-11-90	L5976	6-12	34.1	64.7	35.5	114	107	1550	<1.58	778	11.69	6.8
EPA5	12-11-90	L5977	0-6	53.0	14.8	10.5	559	366	643	<3.00	1340	15.33	7.2
	12-11-90	L5978	6-12	25.6	17.3	3.66	290	165	270	<1.43	595	12.74	7.0
EPA6	12-10-90	L5979	0-6	<10.0	9.80	2.56	83.6	58.1	122	1.30	383	3.59	5.7
	12-10-90	L5980	6-12	<8.60	16.7	4.47	51.6	40.2	96.2	0.741	459	2.51	6.5
	12-10-90	L5981	12-18	<13.2	24.7	9.35	104	107	186	0.895	827	3.86	5.6
EPA7	12-10-90	L5982	0-6	<27.8	35.7	34.3	174	163	1030	<1.67	1410	8.18	7.1
	12-10-90	L5983	6-12	<16.6	32.0	27.3	186	176	779	1.51	915	6.61	7.1
	12-10-90	L5984	12-18	<9.60	22.1	3.94	118	81.3	170	2.06	339	4.15	6.7
EPA8	12-10-90	L5985	0-6	<6.20	4.14	1.13	7.17	7.23	13.1	<0.370	49.3	0.24	6.3
	12-10-90	L5986	6-12	<5.90	2.09	1.49	10.5	12.6	7.76	<0.353	6.38	0.77	6.2
EPA9	12-10-90	L5987	0-6	<31.3	68.1	61.5	144	159	1010	<1.88	2920	7.94	7.1
	12-10-90	L5988	6-12	<21.7	45.2	36.7	108	114	772	<1.30	1700	7.35	6.8
	12-10-90	L5989	12-18	<11.7	21.9	16.1	52.3	51.3	264	<0.698	844	1.70	6.7
EPA10	12-10-90	L5990	0-6	<9.25	17.2	1.11	45.6	29.0	69.1	<0.556	209	3.04	6.6
	12-10-90	L5991	6-12	<8.20	18.4	<0.492	33.9	21.7	38.6	0.639	119	8.29	5.5
	12-10-90	L5992	12-18	<8.20	18.5	<0.492	31.6	20.3	39.2	0.853	105	4.18	5.5
EPA11	12-10-90	L5963	0-6	<7.60	39.4	0.638	38.5	26.8	74.0	<0.455	196	2.90	6.5
	12-10-90	L5964	6-12	<6.85	28.9	0.717	37.9	25.8	62.4	<0.411	224	3.42	6.4
	12-10-90	L5965	12-18	<7.60	10.3	0.926	53.8	35.1	64.0	<0.455	242	2.81	6.0
EPA12	12-11-90	L5966	0-6	<6.65	1.35	<0.399	20.7	15.9	21.6	<0.400	63.8	0.83	6.1
	12-11-90	L5967	6-12	<6.10	1.55	0.717	42.9	6.62	6.44	<0.366	54.1	0.94	5.9
EPA13	12-12-90	L5968	0-6	1300	235	37.3	31.7	131	26800	3.80	279	8.81	5.6

Table 5 5/12/93

NL Industries, Inc. Site

New Jersey Drinking Water MCLs

	New Jersey MCL
HAZARDOUS CONTAMINANT (ppb)	
Benzene	1
Carbon Tetrachloride	2
Chlordane	0.5
Chlorobenzene	4
Dichlorobenzene(s)	
o-	600
m-	600
p-	--
1,2-Dichloroethane	2
1,1-Dichloroethylene	2
1,2-Dichloroethylene (cis and trans)	10
Ethylene Glycol	--
Formaldehyde	--
n-Hexane	--
Kerosene	--
Methyl Ethyl Ketone	--
Methylene Chloride	2
Polychlorinated biphenyls (PCBs)(total)	0.5
Tetrachloroethylene	1
Trichlorobenzene(s) (1,2,4-Trichlorobenzene)	8
1,1,1-Trichloroethane	26
Trichloroethylene	1
Vinyl Chloride	2
Xylene(s)	44
VOLATILES (ppm)	
1,3-Dichlorobenzene	0.6
1,1-Dichloroethane	--
1,1-Dichloroethene	0.002
Ethylbenzene	--
Tetrachloroethene	0.001
Toluene	--
METALS (ppm)	
Antimony	--
Arsenic	0.05
Beryllium	--
Cadmium	0.01
Chloride	250
Chromium	0.05
Copper	1
Lead	0.015
Mercury	0.002
Nickel	--
Selenium	0.01
Silver	0.05
Sulfate	250
Thallium	--
Zinc	5

-- New Jersey has no established MCLs for these contaminants.

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NL Industries, Inc. Site
Soil Alternative A -Cost Estimate (1,3)
NO ACTION/INSTITUTIONAL CONTROLS

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation					
Mobilization/Site Prep.	1.00	LS	$5,000.00	$5,000	
Site Work					
Clear and Grub	1.00	ACRE	$8,000.00	$8,000	
Fencing	6,000.00	LF	$15.00	$90,000	
Subtotal					$103,000
TOTAL DIRECT CAPITAL COSTS:					**$103,000**
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$26,000	
Engineering (15% +/-)				$15,000	
Administration (5% +/-)				$5,000	
TOTAL INDIRECT CAPITAL COSTS:					**$46,000**
TOTAL CAPITAL COSTS					**$149,000**
ANNUAL MAINTENANCE COSTS					
Inspections/Maintenance	1.00	LS	$2,000.00	$2,000	
TOTAL ANNUAL COSTS:					$2,000
PRESENT WORTH (30 YR @ 5%):					$30,400
TOTAL ESTIMATED REMEDIAL COST:					$179,400

Notes:
1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget cost only.
3. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for the comparison of technical alternatives.

Table 7 5/12/93

NL Industries, Inc. Site

Soil Alternative B (1000 ppm) – Cost Estimate (1,5)

EXCAVATION/SOIL WASHING OF ALL SOILS/RETURN TREATED SOILS TO SITE/DISPOSAL

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation					
Mobilization/Site Prep.	1.00	LS	$500,000.00	$500,000	
Road Relocation	1.00	LS	$35,000.00	$35,000	
Health and Safety Plan	1.00	LS	$20,000.00	$20,000	
Erosion/Sediment/Dust Control	1.00	LS	$50,000.00	$50,000	
Wooded Area Access	8.50	ACRE	$8,000.00	$68,000	
Treatability Testing	1.00	LS	$150,000.00	$150,000	
Subtotal					$823,000
Site Work					
Excavating/Load (On-Site)	20,000.00	CY	$15.00	$300,000	
Excavating/Load (Off-Site)	1,000.00	CY	$15.00	$15,000	
Truck Haul (4)	24,100.00	CY	$5.00	$120,500	
Confirmational Sampling	25.00	EA	$100.00	$2,500	
Subtotal					$438,000
On-Site Restoration (3)					
Topsoil/Fill	16,000.00	CY	$20.00	$320,000	
Earthwork	19.00	ACRE	$5,000.00	$95,000	
Hydroseed	13.00	ACRE	$3,500.00	$45,500	
Wetlands Vegetation	6.00	ACRE	$15,000.00	$90,000	
Subtotal					$550,500
Off-Site Restoration (3)					
Topsoil/Fill	2,100.00	CY	$20.00	$42,000	
Earthwork	2.50	ACRE	$5,000.00	$12,500	
Wetlands Vegetation	2.50	ACRE	$15,000.00	$37,500	
Subtotal					$92,000
Soil Washing/Disposal (4)					
Soil Washing	24,100.00	CY	$200.00	$4,820,000	
Haul & Backfill Clean Soil	17,000.00	CY	$5.00	$85,000	
Solidify Fines	7,100.00	CY	$100.00	$710,000	
Haul Fines Off-Site	10,500.00	CY	$50.00	$525,000	
Dispose Fines Off-Site	10,500.00	CY	$100.00	$1,050,000	
Bench Scale/Full Scale Demonstration	1.00	LS	$100,000.00	$100,000	
Subtotal					$7,290,000
TOTAL DIRECT CAPITAL COSTS					**$9,193,500**
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$2,298,000	
Engineering (15% +/-)				$1,379,000	
Administration (5% +/-)				$460,000	
Permitting				$100,000	
TOTAL INDIRECT CAPITAL COSTS					**$4,237,000**
TOTAL CAPITAL COSTS					**$13,431,000**
ANNUAL MAINTENANCE COSTS					
Cap Maintenance	1.00	LS	$5,000.00	$5,000	
TOTAL ANNUAL COSTS					**$5,000**
PRESENT WORTH (30 YR @ 5%)					**$77,000**
TOTAL ESTIMATED REMEDIAL COST					**$13,508,000**

Notes:

1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget cost only.
3. Restoration includes regrading excavated areas and installation of 6 inches of topsoil to establish vegetation.
4. Includes 500 CY of stream sediment.
5. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

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NL Industries, Inc. Site

Soil Alternative B (500 ppm) – Cost Estimate (1,5)

EXCAVATION/SOIL WASHING OF ALL SOILS/RETURN TREATED SOILS TO SITE/DISPOSAL

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation					
Mobilization/Site Prep.	1.00	LS	$500,000.00	$500,000	
Road Relocation	1.00	LS	$35,000.00	$35,000	
Health and Safety Plan	1.00	LS	$20,000.00	$20,000	
Erosion/Sediment/Dust Control	1.00	LS	$50,000.00	$50,000	
Wooded Area Access	15.00	ACRE	$8,000.00	$120,000	
Treatability Testing	1.00	LS	$150,000.00	$150,000	
Subtotal					$875,000
Site Work					
Excavating/Load (On-Site)	28,000.00	CY	$15.00	$420,000	
Excavating/Load (Off-Site)	1,800.00	CY	$15.00	$27,000	
Truck Haul (4)	35,800.00	CY	$5.00	$179,000	
Confirmational Sampling	33.00	EA	$100.00	$3,300	
Subtotal					$629,300
On-Site Restoration (3)					
Topsoil/Fill	22,000.00	CY	$20.00	$440,000	
Earthwork	27.00	ACRE	$5,000.00	$135,000	
Hydroseed	15.00	ACRE	$3,500.00	$52,500	
Wetlands Vegetation	12.00	ACRE	$15,000.00	$180,000	
Subtotal					$807,500
Off-Site Restoration (3)					
Topsoil/Fill	2,450.00	CY	$20.00	$49,000	
Earthwork	3.00	ACRE	$5,000.00	$15,000	
Wetlands Vegetation	3.00	ACRE	$15,000.00	$45,000	
Subtotal					$109,000
Soil Washing/Disposal (4)					
Soil Washing	35,800.00	CY	$200.00	$7,160,000	
Haul & Backfill With Clean Soil	25,000.00	CY	$5.00	$125,000	
Solidify Fines	10,800.00	CY	$100.00	$1,080,000	
Haul Fines Off-Site	16,200.00	CY	$50.00	$810,000	
Dispose Fines Off-Site	16,200.00	CY	$100.00	$1,620,000	
Bench Scale/Full Scale Demonstration	1.00	LS	$100,000.00	$100,000	
Subtotal					$10,895,000
TOTAL DIRECT CAPITAL COSTS					$13,315,800
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$3,329,000	
Engineering (15% +/-)				$1,997,000	
Administration (5% +/-)				$666,000	
Permitting				$100,000	
TOTAL INDIRECT CAPITAL COSTS					$6,092,000
TOTAL CAPITAL COSTS					$19,408,000
ANNUAL MAINTENANCE COSTS					
Cap Maintenance	1.00	LS	$5,000.00	$5,000	
TOTAL ANNUAL COSTS					$5,000
PRESENT WORTH (30 YR @ 5%)					$77,000
TOTAL ESTIMATED REMEDIAL COST					$19,485,000

Notes:

1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget cost only.
3. Restoration includes regrading excavated areas and installation of 6 inches of topsoil to establish vegetation.
4. Includes 1,500 CY of stream sediment.
5. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

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NL Industries, Inc. Site

Soil Alternative C (1,000 ppm) - Cost Estimate (1,5)

EXCAVATION/SOLIDIFICATION/STABILIZATION OF ALL SOILS/CONSOLIDATION ON-SITE

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation					
Mobilization/Site Prep.	1.00	LS	$200,000.00	$200,000	
Road Relocation	1.00	LS	$35,000.00	$35,000	
Health and Safety Plan	1.00	LS	$20,000.00	$20,000	
Erosion/Sediment/Dust Control	1.00	LS	$50,000.00	$50,000	
Wooded Area Access	8.50	ACRE	$8,000.00	$68,000	
Treatability Testing	1.00	LS	$50,000.00	$50,000	
Subtotal					$423,000
Site Work					
Excavating/Load (On-Site)	20,000.00	CY	$15.00	$300,000	
Excavating/Load (Off-Site)	1,000.00	CY	$15.00	$15,000	
Truck Haul (4)	24,100.00	CY	$5.00	$120,500	
Confirmational Sampling	25.00	EA	$100.00	$2,500	
Subtotal					$438,000
On-Site Restoration (3)					
Topsoil/Fill	16,000.00	CY	$20.00	$320,000	
Earthwork	19.00	ACRE	$5,000.00	$95,000	
Hydroseed	13.00	ACRE	$3,500.00	$45,500	
Wetlands Vegetation	6.00	ACRE	$15,000.00	$90,000	
Subtotal					$550,500
Off-Site Restoration (3)					
Topsoil/Fill	2,100.00	CY	$20.00	$42,000	
Earthwork	2.50	ACRE	$5,000.00	$12,500	
Wetlands Vegetation	2.50	ACRE	$15,000.00	$37,500	
Subtotal					$92,000
Solidification/Disposal (4)					
Soil Treatment, On-Site	24,100.00	CY	$100.00	$2,410,000	
Haul On-Site	36,200.00	CY	$5.00	$181,000	
Subtotal					$2,591,000
On_site Consolidation Area					
Surface Prep/Cap Base Grading	5,200.00	CY	$5.00	$26,000	
Disposal Soil Grading (4)	36,200.00	CY	$5.00	$181,000	
40 mil VLDPE Geomembrane	56,000.00	SF	$1.00	$56,000	
Drainage Layer (6")	1,000.00	CY	$10.00	$10,000	
Root Zone Soil (24" Layer)	4,200.00	CY	$15.00	$63,000	
Topsoil (6" Layer)	1,000.00	CY	$20.00	$20,000	
Seed, Fertilize, and Mulch	2.00	ACRE	$5,000.00	$10,000	
Liner System	1.00	LS	$550,000.00	$550,000	
Subtotal					$916,000
TOTAL DIRECT CAPITAL COSTS					**$5,010,500**
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$1,253,000	
Engineering (15% +/-)				$752,000	
Administration (5% +/-)				$251,000	
Permitting				$100,000	
TOTAL INDIRECT CAPITAL COSTS					**$2,356,000**
TOTAL CAPITAL COSTS					**$7,367,000**
ANNUAL MAINTENANCE COSTS					
Cap Maintenance	1.00	LS	$5,000.00	$5,000	
TOTAL ANNUAL COSTS					**$5,000**
PRESENT WORTH (30 YR @ 5%)					**$77,000**
TOTAL ESTIMATED REMEDIAL COST					**$7,444,00(**

Notes:

1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget cost only.
3. Restoration includes regrading excavated areas and installation of 6 inches of topsoil to establish vegetation.
4. Includes 1,500 CY of stream sediment.
5. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

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Table 10

NL Industries, Inc. Site

Soil Alternative C (500 ppm) - Cost Estimate (1,5)

EXCAVATION/SOLIDIFICATION/STABILIZATION OF ALL SOILS/CONSOLIDATION ON-SITE

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation					
Mobilization/Site Prep.	1.00	LS	$200,000.00	$200,000	
Road Relocation	1.00	LS	$35,000.00	$35,000	
Health and Safety Plan	1.00	LS	$20,000.00	$20,000	
Erosion/Sediment/Dust Control	1.00	LS	$50,000.00	$50,000	
Wooded Area Access	15.00	ACRE	$8,000.00	$120,000	
Treatability Testing	1.00	LS	$50,000.00	$50,000	
Subtotal					$475,000
Site Work					
Excavating/Load (On-Site)	28,000.00	CY	$15.00	$420,000	
Excavating/Load (Off-Site)	1,800.00	CY	$15.00	$27,000	
Truck Haul (4)	35,800.00	CY	$5.00	$179,000	
Confirmational Sampling	33.00	EA	$100.00	$3,300	
Subtotal					$629,300
On-Site Restoration (3)					
Topsoil/Fill	22,000.00	CY	$20.00	$440,000	
Earthwork	27.00	ACRE	$5,000.00	$135,000	
Hydroseed	15.00	ACRE	$3,500.00	$52,500	
Wetlands Vegetation	12.00	ACRE	$15,000.00	$180,000	
Subtotal					$807,500
Off-Site Restoration (3)					
Topsoil/Fill	2,450.00	CY	$20.00	$49,000	
Earthwork	3.00	ACRE	$5,000.00	$15,000	
Wetlands Vegetation	3.00	ACRE	$15,000.00	$45,000	
Subtotal					$109,000
Solidification/Disposal (4)					
Soil Treatment, On-Site	35,800.00	CY	$100.00	$3,580,000	
Haul On-Site	53,700.00	CY	$5.00	$268,500	
Subtotal					$3,848,500
On_site Consolidation Area					
Surface Prep/Cap Base Grading	9,500.00	CY	$5.00	$47,500	
Disposal Soil Grading (4)	53,700.00	CY	$5.00	$268,500	
40 mil VLDPE Geomembrane	100,000.00	SF	$1.00	$100,000	
Drainage Layer (6")	1,800.00	CY	$10.00	$18,000	
Root Zone Soil (24" Layer)	7,500.00	CY	$15.00	$112,500	
Topsoil (6" Layer)	1,800.00	CY	$20.00	$36,000	
Seed, Fertilize, and Mulch	2.00	ACRE	$5,000.00	$10,000	
Liner System	1.00	LS	$600,000.00	$600,000	
Subtotal					$1,192,500
TOTAL DIRECT CAPITAL COSTS					**$7,061,800**
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$1,765,000	
Engineering (15% +/-)				$1,059,000	
Administration (5% +/-)				$353,000	
Permitting				$100,000	
TOTAL INDIRECT CAPITAL COSTS					**$3,277,000**
TOTAL CAPITAL COSTS					**$10,339,000**
ANNUAL MAINTENANCE COSTS					
Cap Maintenance	1.00	LS	$5,000.00	$5,000	
TOTAL ANNUAL COSTS					**$5,000**
PRESENT WORTH (30 YR @ 5%)					**$77,000**
TOTAL ESTIMATED REMEDIAL COST					**$10,416,000**

Notes:

1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget cost only.
3. Restoration includes regrading excavated areas and installation of 6 inches of topsoil to establish vegetation.
4. Includes 1,500 CY of stream sediment.
5. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

NLI 002 0780

Table 11
NL Industries, Inc. Site
Soil Alternative D (1000 ppm) – Cost Estimate (1,5)
EXCAVATION/SOIL WASHING OF HAZARDOUS SOILS/ON-SITE CONSOLIDATION/DISPOSAL

5/12/93

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation					
Mobilization/Site Prep.	1.00	LS	$500,000.00	$500,000	
Road Relocation	1.00	LS	$35,000.00	$35,000	
Health and Safety Plan	1.00	LS	$20,000.00	$20,000	
Erosion/Sediment/Dust Control	1.00	LS	$50,000.00	$50,000	
Wooded Area Access	8.50	ACRE	$8,000.00	$68,000	
Treatability Testing	1.00	LS	$150,000.00	$150,000	
Subtotal					$823,000
Site Work					
Excavating/Load (On-Site)	20,000.00	CY	$15.00	$300,000	
Excavating/Load (Off-Site)	1,000.00	CY	$15.00	$15,000	
Truck Haul (4)	24,100.00	CY	$5.00	$120,500	
Confirmational Sampling	25.00	EA	$100.00	$2,500	
Subtotal					$438,000
On-Site Restoration (3)					
Topsoil/Fill	16,000.00	CY	$20.00	$320,000	
Earthwork	19.00	ACRE	$5,000.00	$95,000	
Hydroseed	13.00	ACRE	$3,500.00	$45,500	
Wetlands Vegetation	6.00	ACRE	$15,000.00	$90,000	
Subtotal					$550,500
Off-Site Restoration (3)					
Topsoil/Fill	2,100.00	CY	$20.00	$42,000	
Earthwork	2.50	ACRE	$5,000.00	$12,500	
Wetlands Vegetation	2.50	ACRE	$15,000.00	$37,500	
Subtotal					$92,000
On-Site Consolidation Pile					
Surface Prep/Cap Base Grading	5,200.00	CY	$5.00	$26,000	
Disposal Soil Grading (4)	14,100.00	CY	$5.00	$70,500	
40 mil VLDPE Geomembrane	56,000.00	SF	$1.00	$56,000	
Drainage Layer (6")	1,000.00	CY	$10.00	$10,000	
Root Zone Soil (24" Layer)	4,200.00	CY	$15.00	$63,000	
Topsoil (6" layer)	1,000.00	CY	$20.00	$20,000	
Seed, Fertilize, and Mulch	1.30	ACRE	$5,000.00	$6,500	
Liner System	1.00	LS	$550,000.00	$550,000	
Subtotal					$802,000
Soil Washing/Disposal					
Soil Washing	5,000.00	CY	$200.00	$1,000,000	
Haul & Backfill Clean Soil	3,500.00	CY	$5.00	$17,500	
Solidify Fines	1,500.00	CY	$100.00	$150,000	
Haul Fines Off-Site	2,300.00	CY	$50.00	$115,000	
Dispose Fines Off-Site	2,300.00	CY	$100.00	$230,000	
Haul Off-Site	5,000.00	CY	$50.00	$250,000	
Disposal Off-Site	5,000.00	CY	$285.00	$1,425,000	
Bench Scale/Full Scale Demonstration	1.00	LS	$100,000.00	$100,000	
Subtotal					$3,287,500
TOTAL DIRECT CAPITAL COSTS					$5,993,000
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$1,498,000	
Engineering (15% +/-)				$899,000	
Administration (5% +/-)				$300,000	
Permitting				$100,000	
TOTAL INDIRECT CAPITAL COSTS					$2,797,000
TOTAL CAPITAL COSTS					$8,790,000
ANNUAL MAINTENANCE COSTS					
Cap Maintenance	1.00	LS	$5,000.00	$5,000	
TOTAL ANNUAL COSTS					$5,000
PRESENT WORTH (30 YR @ 5%)					$77,000
TOTAL ESTIMATED REMEDIAL COST					$8,867,000

Notes:
1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget cost only.
3. Restoration includes regrading excavated areas and installation of 6 inches of topsoil to establish vegetation.
4. Includes 500 CY of stream sediment.
5. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

NL I 002 0781

Table 12

5/12/93

NL Industries, Inc. Site

Soil Alternative D (500 ppm) – Cost Estimate (1,5)

EXCAVATION/SOIL WASHING OF HAZARDOUS SOIL/ON-SITE CONSOLIDATION/DISPOSAL

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation					
Mobilization/Site Prep.	1.00	LS	$500,000.00	$500,000	
Road Relocation	1.00	LS	$35,000.00	$35,000	
Health and Safety Plan	1.00	LS	$20,000.00	$20,000	
Erosion/Sediment/Dust Control	1.00	LS	$50,000.00	$50,000	
Wooded Area Access	15.00	ACRE	$8,000.00	$120,000	
Treatability Testing	1.00	LS	$150,000.00	$150,000	
Subtotal					$875,000
Site Work					
Excavating/Load (On-Site)	28,000.00	CY	$15.00	$420,000	
Excavating/Load (Off-Site)	1,800.00	CY	$15.00	$27,000	
Truck Haul (4)	35,800.00	CY	$5.00	$179,000	
Confirmational Sampling	33.00	EA	$100.00	$3,300	
Subtotal					$629,300
On-Site Restoration (3)					
Topsoil/Fill	22,000.00	CY	$20.00	$440,000	
Earthwork	27.00	ACRE	$5,000.00	$135,000	
Hydroseed	15.00	ACRE	$3,500.00	$52,500	
Wetlands Vegetation	12.00	ACRE	$15,000.00	$180,000	
Subtotal					$807,500
Off-Site Restoration (3)					
Topsoil/Fill	2,450.00	CY	$20.00	$49,000	
Earthwork	3.00	ACRE	$5,000.00	$15,000	
Wetlands Vegetation	3.00	ACRE	$15,000.00	$45,000	
Subtotal					$109,000
On-Site Consolidation Pile					
Surface Prep/Cap Base Grading	7,400.00	CY	$5.00	$37,000	
Disposal Soil Grading (4)	25,800.00	CY	$5.00	$129,000	
40 mil VLDPE Geomembrane	79,000.00	SF	$1.00	$79,000	
Drainage Layer (6")	1,400.00	CY	$10.00	$14,000	
Root Zone Soil (24" Layer)	5,800.00	CY	$15.00	$87,000	
Topsoil (6" layer)	1,400.00	CY	$20.00	$28,000	
Seed, Fertilize, and Mulch	1.80	ACRE	$5,000.00	$9,000	
Liner System	1.00	LS	$550,000.00	$550,000	
Subtotal					$933,000
Soil Washing/Disposal					
Soil Washing	5,000.00	CY	$200.00	$1,000,000	
Haul & Backfill With Clean Soil	3,500.00	CY	$5.00	$17,500	
Solidify Fines	1,500.00	CY	$100.00	$150,000	
Haul Fines Off-Site	2,300.00	CY	$50.00	$115,000	
Dispose Fines Off-Site	2,300.00	CY	$100.00	$230,000	
Haul Off-Site	5,000.00	CY	$50.00	$250,000	
Disposal Off-Site	5,000.00	CY	$285.00	$1,425,000	
Bench Scale/Full Scale Demonstration	1.00	LS	$550,000.00	$550,000	
Subtotal					$3,737,500
TOTAL DIRECT CAPITAL COSTS					$7,091,300
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$1,773,000	
Engineering (15% +/-)				$1,064,000	
Administration (5% +/-)				$355,000	
Permitting				$100,000	
TOTAL INDIRECT CAPITAL COSTS					$3,292,000
TOTAL CAPITAL COSTS					$10,383,300
ANNUAL MAINTENANCE COSTS					
Cap Maintenance	1.00	LS	$5,000.00	$5,000	
TOTAL ANNUAL COSTS					$5,000
PRESENT WORTH (30 YR @ 5%)					$77,000
TOTAL ESTIMATED REMEDIAL COST					$10,460,300

Notes:

1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget cost only.
3. Restoration includes regrading excavated areas and installation of 6 inches of topsoil to establish vegetation.
4. Includes 1,500 CY of stream sediment.
5. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

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Table 13 5/12/93
NL Industries, Inc. Site
Soil Alternative E (1000 ppm) - Cost Estimate (1,5)
EXCAVATION/ON-SITE SOLIDIFICATION/STABILIZATION OF HAZARDOUS SOILS/DISPOSAL

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation					
Mobilization/Site Prep.	1.00	LS	$200,000.00	$200,000	
Road Relocation	1.00	LS	$35,000.00	$35,000	
Health and Safety Plan	1.00	LS	$20,000.00	$20,000	
Erosion/Sediment/Dust Control	1.00	LS	$50,000.00	$50,000	
Wooded Area Access	8.50	ACRE	$8,000.00	$68,000	
Treatability Testing	1.00	LS	50,000.00	$50,000	
Subtotal					$423,000
Site Work					
Excavating/Load (On-Site)	20,000.00	CY	$15.00	$300,000	
Excavating/Load (Off-Site)	1,000.00	CY	$15.00	$15,000	
Truck Haul (4)	24,100.00	CY	$5.00	$120,500	
Confirmational Sampling	25.00	EA	$100.00	$2,500	
Subtotal					$438,000
On-Site Restoration (3)					
Topsoil/Fill	16,000.00	CY	$20.00	$320,000	
Earthwork	19.00	ACRE	$5,000.00	$95,000	
Hydroseed	13.00	ACRE	$3,500.00	$45,500	
Wetlands Vegetation	6.00	ACRE	$15,000.00	$90,000	
Subtotal					$550,500
Off-Site Restoration (3)					
Topsoil/Fill	2,100.00	CY	$20.00	$42,000	
Earthwork	2.50	ACRE	$5,000.00	$12,500	
Wetlands Vegetation	2.50	ACRE	$15,000.00	$37,500	
Subtotal					$92,000
Solidification/Disposal					
Soil Treatment (4)	5,000.00	CY	$100.00	$500,000	
Haul Offsite, Treated Soil	7,500.00	CY	$50.00	$375,000	
Dispose Offsite, Hazardous, Untreated	5,000.00	CY	$50.00	$250,000	
Dispose Offsite, Hazardous, Untreated	5,000.00	CY	$285.00	$1,425,000	
Dispose Offsite, Treated Soil	7,500.00	CY	$100.00	$750,000	
Subtotal					$3,300,000
On-Site Consolidation Area					
Surface Prep/Cap Base Grading	5,200.00	CY	$5.00	$26,000	
Disposal Soil Grading (4)	14,100.00	CY	$5.00	$70,500	
40 mil VLDPE Geomembrane	56,000.00	SF	$1.00	$56,000	
Drainage Layer (6")	1,000.00	CY	$10.00	$10,000	
Root Zone Soil (24" Layer)	4,200.00	CY	$15.00	$63,000	
Topsoil (6") Layer	1,000.00	CY	$20.00	$20,000	
Seed, Fertilize, and Mulch	1.30	ACRE	$5,000.00	$6,500	
Liner System	1.00	LS	$550,000.00	$550,000	
Subtotal					$802,000
TOTAL DIRECT CAPITAL COSTS					**$5,605,500**
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$1,401,000	
Engineering (15% +/-)				$841,000	
Administration (5% +/-)				$280,000	
Permitting				$100,000	
TOTAL INDIRECT CAPITAL COSTS					**$2,622,000**
TOTAL CAPITAL COSTS					**$8,228,000**
ANNUAL MAINTENANCE COSTS					
Cap Maintenance	1.00	LS	$5,000.00	$5,000	
TOTAL ANNUAL COSTS					**$5,000**
PRESENT WORTH (30 YR @ 5%)					**$77,000**
TOTAL ESTIMATED REMEDIAL COST					**$8,305,000**

NLI 002 0783

Notes:
1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget cost only.
3. Restoration includes regrading excavated areas and installation of 6 inches of topsoil to establish vegetation.
4. Includes 500 CY of stream sediment.
5. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives Because of the incomplete nature of this data and the possibility that act conditions may vary considerably from these base assumptions, these c are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

Table 14
NL Industries, Inc. Site
Soil Alternative E (500 ppm) - Cost Estimate (1,5)
EXCAVATION/ON-SITE SOLIDIFICATION/STABILIZATION OF HAZARDOUS SOILS/DISPOSAL

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation					
Mobilization/Site Prep.	1.00	LS	$200,000.00	$200,000	
Road Relocation	1.00	LS	$35,000.00	$35,000	
Health and Safety Plan	1.00	LS	$20,000.00	$20,000	
Erosion/Sediment/Dust Control	1.00	LS	$50,000.00	$50,000	
Wooded Area Access	15.00	ACRE	$8,000.00	$120,000	
Treatability Testing	1.00	LS	$50,000.00	$50,000	
Subtotal					$475,000
Site Work					
Excavating/Load (On-Site)	28,000.00	CY	$15.00	$420,000	
Excavating/Load (Off-Site)	1,800.00	CY	$15.00	$27,000	
Truck Haul	35,800.00	CY	$5.00	$179,000	
Confirmational Sampling	33.00	EA	$100.00	$3,300	
Subtotal					$629,300
On-Site Restoration (3)					
Topsoil/Fill	22,000.00	CY	$20.00	$440,000	
Earthwork	27.00	ACRE	$5,000.00	$135,000	
Hydroseed	15.00	ACRE	$3,500.00	$52,500	
Wetlands Vegetation	12.00	ACRE	$15,000.00	$180,000	
Subtotal					$807,500
Off-Site Restoration (3)					
Topsoil/Fill	2,450.00	CY	$20.00	$49,000	
Earthwork	3.00	ACRE	$5,000.00	$15,000	
Wetlands Vegetation	3.00	ACRE	$15,000.00	$45,000	
Subtotal					$109,000
Solidification/Disposal					
Soil Treatment	5,000.00	CY	$100.00	$500,000	
Haul Offsite, Treated Soil	7,500.00	CY	$50.00	$375,000	
Haul Offsite, Hazardous, Untreated	5,000.00	CY	$50.00	$250,000	
Dispose Offsite, Hazardous, Untreated	5,000.00	CY	$285.00	$1,425,000	
Dispose Offsite, Treated Soil	7,500.00	CY	$100.00	$750,000	
Subtotal					$3,300,000
On-Site Consolidation Area					
Surface Prep/Cap Base Grading	7,400.00	CY	$5.00	$37,000	
Disposal Soil Grading (4)	25,800.00	CY	$5.00	$129,000	
40 mil VLDPE Geomembrane	7,900.00	SF	$1.00	$7,900	
Drainage Layer (6")	1,400.00	CY	$10.00	$14,000	
Root Zone Soill (24")	5,800.00	CY	$15.00	$87,000	
Topsoil (6" Layer)	1,400.00	CY	$20.00	$28,000	
Seed, Fertilize, and Mulch	1.80	ACRE	$5,000.00	$9,000	
Liner System	1.00	LS	$550,000.00	$550,000	
Subtotal					$861,900
TOTAL DIRECT CAPITAL COSTS					**$6,182,700**
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$1,546,000	
Engineering (15% +/-)				$927,000	
Administration (5% +/-)				$309,000	
Permitting				$100,000	
TOTAL INDIRECT CAPITAL COSTS					**$2,882,000**
TOTAL CAPITAL COSTS					**$9,065,000**
ANNUAL MAINTENANCE COSTS					
Cap Maintenance	1.00	LS	$5,000.00	$5,000	
TOTAL ANNUAL COSTS					**$5,000**
PRESENT WORTH (30 YR @ 5%)					**$77,000**
TOTAL ESTIMATED REMEDIAL COST					**$9,142,000**

Notes:

1. **Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.**
2. **Line items provided to form budget cost only.**
3. **Restoration includes regrading excavated areas and installation of 6 inches of topsoil to establish vegetation.**
4. **Includes 1,500 CY of stream sediment.**
5. **The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.**

NLI 002 0784

Table 15

NL Industries, Inc. Site

Soil Alternative F (1000 ppm) - Cost Estimate (1,5)

EXCAVATION/ON-SITE SOLIDIFICATION/STABILIZATION OF HAZARDOUS SOILS/CONSOLIDATION ON-SITE

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation					
Mobilization/Site Prep.	1.00	LS	$200,000.00	$200,000	
Road Relocation	1.00	LS	$35,000.00	$35,000	
Health and Safety Plan	1.00	LS	$20,000.00	$20,000	
Erosion/Sediment/Dust Control	1.00	LS	$50,000.00	$50,000	
Wooded Area Access	8.50	ACRE	$8,000.00	$68,000	
Treatability Testing	1.00	LS	50,000.00	$50,000	
Subtotal					$423,000
Site Work					
Excavating/Load (On-Site)	20,000.00	CY	$15.00	$300,000	
Excavating/Load (Off-Site)	1,000.00	CY	$15.00	$15,000	
Truck Haul (4)	24,100.00	CY	$5.00	$120,500	
Confirmational Sampling	25.00	EA	$100.00	$2,500	
Subtotal					$438,000
On-Site Restoration (3)					
Topsoil/Fill	16,000.00	CY	$20.00	$320,000	
Earthwork	19.00	ACRE	$5,000.00	$95,000	
Hydroseed	13.00	ACRE	$3,500.00	$45,500	
Wetlands Vegetation	6.00	ACRE	$15,000.00	$90,000	
Subtotal					$550,500
Off-Site Restoration (3)					
Topsoil/Fill	2,100.00	CY	$20.00	$42,000	
Earthwork	2.50	ACRE	$5,000.00	$12,500	
Wetlands Vegetation	2.50	ACRE	$15,000.00	$37,500	
Subtotal					$92,000
On-Site Consolidation Pile					
Surface Prep/Cap Base Grading	5,200.00	CY	$5.00	$26,000	
Disposal Soil Grading (4)	29,100.00	CY	$5.00	$145,500	
40 mil VLDPE Geomembrane	56,000.00	SF	$1.00	$56,000	
Drainage Layer (6")	1,000.00	CY	$10.00	$10,000	
Root Zone Soil (24" Layer)	4,200.00	CY	$15.00	$63,000	
Topsoil (6" layer)	1,000.00	CY	$20.00	$20,000	
Seed, Fertilize, and Mulch	1.30	ACRE	$5,000.00	$6,500	
Liner System	1.00	LS	$550,000.00	$550,000	
Subtotal					$877,000
On-Site Solidification/Consolidation					
Soil Treatment (4)	10,000.00	CY	$100.00	$1,000,000	
Haul On-Site	15,000.00	CY	$5.00	$75,000	
Subtotal					$1,075,000
TOTAL DIRECT CAPITAL COSTS					**$3,455,500**
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$864,000	
Engineering (15% +/-)				$518,000	
Administration (5% +/-)				$173,000	
Permitting				$100,000	
TOTAL INDIRECT CAPITAL COSTS					**$1,655,000**
TOTAL CAPITAL COSTS					**$5,111,000**
ANNUAL MAINTENANCE COSTS					
Cap Maintenance	1.00	LS	$5,000.00	$5,000	
TOTAL ANNUAL COSTS					**$5,000**
PRESENT WORTH (30 YR @ 5%)					**$77,000**
TOTAL ESTIMATED REMEDIAL COST					**$5,188,000**

Notes:

1. Cost estimate based on R.S. Means 1990 Construction Cost Dat O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget cost only.
3. Restoration includes regrading excavated areas and installation of 6 inches of topsoil to establish vegetation.
4. Includes 500 CY of stream sediment.
5. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

Table 16

NL Industries, Inc. Site

Soil Alternative F (500 ppm) - Cost Estimate (1,5)

EXCAVATION/ON-SITE SOLIDIFICATION/STABILIZATION OF HAZARDOUS SOILS/CONSOLIDATION ON-SITE

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation					
Mobilization/Site Prep.	1.00	LS	$200,000.00	$200,000	
Road Relocation	1.00	LS	$35,000.00	$35,000	
Health and Safety Plan	1.00	LS	$20,000.00	$20,000	
Erosion/Sediment/Dust Control	1.00	LS	$50,000.00	$50,000	
Wooded Area Access	15.00	ACRE	$8,000.00	$120,000	
Treatability Testing	1.00	LS	$50,000.00	$50,000	
Subtotal					$475,000
Site Work					
Excavating/Load (On-Site)	28,000.00	CY	$15.00	$420,000	
Excavating/Load (Off-Site)	1,800.00	CY	$15.00	$27,000	
Truck Haul (4)	35,800.00	CY	$5.00	$179,000	
Confirmational Sampling	33.00	EA	$100.00	$3,300	
Subtotal					$629,300
On-Site Restoration (3)					
Topsoil/Fill	22,000.00	CY	$20.00	$440,000	
Earthwork	27.00	ACRE	$5,000.00	$135,000	
Hydroseed	15.00	ACRE	$3,500.00	$52,500	
Wetlands Vegetation	12.00	ACRE	$15,000.00	$180,000	
Subtotal					$807,500
Off-Site Restoration (3)					
Topsoil/Fill	2,450.00	CY	$20.00	$49,000	
Earthwork	3.00	ACRE	$5,000.00	$15,000	
Wetlands Vegetation	3.00	ACRE	$15,000.00	$45,000	
Subtotal					$109,000
On-Site Consolidation Pile					
Surface Prep/Cap Base Grading	7,400.00	CY	$5.00	$37,000	
Disposal Soil Grading (4)	40,800.00	CY	$5.00	$204,000	
40 mil VLDPE Geomembrane	79,000.00	SF	$1.00	$79,000	
Drainage Layer (6")	1,400.00	CY	$10.00	$14,000	
Root Zone Soil (24" Layer)	5,800.00	CY	$15.00	$87,000	
Topsoil (6" layer)	1,400.00	CY	$20.00	$28,000	
Seed, Fertilize, and Mulch	1.80	ACRE	$5,000.00	$9,000	
Liner System	1.00	LS	$550,000.00	$550,000	
Subtotal					$1,008,000
On-Site Solidification/Consolidation					
Soil Treatment	10,000.00	CY	$100.00	$1,000,000	
Haul On-Site	15,000.00	CY	$5.00	$75,000	
Subtotal					$1,075,000
TOTAL DIRECT CAPITAL COSTS					**$4,103,800**
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$1,026,000	
Engineering (15% +/-)				$616,000	
Administration (5% +/-)				$205,000	
Permitting				$100,000	
TOTAL INDIRECT CAPITAL COSTS					**$1,947,000**
TOTAL CAPITAL COSTS					**$6,051,000**
ANNUAL MAINTENANCE COSTS					
Cap Maintenance	1.00	LS	$5,000.00	$5,000	
TOTAL ANNUAL COSTS					**$5,000**
PRESENT WORTH (30 YR @ 5%)					**$77,000**
TOTAL ESTIMATED REMEDIAL COST					**$6,128,000**

Notes:

1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget cost only.
3. Restoration includes regrading excavated areas and installation of 6 inches of topsoil to establish vegetation.
4. Includes 1,500 CY of stream sediment.
5. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

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Table 17

NL Industries, Inc. Site

Soil Alternative G (1000 ppm) - Cost Estimate (1,4)

EXCAVATION/OFF-SITE DISPOSAL

Items (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation					
Mobilization/Site Prep.	1.00	LS	$150,000.00	$150,000	
Health and Safety Plan	1.00	LS	$20,000.00	$20,000	
Erosion/Sediment/Dust Control	1.00	LS	$30,000.00	$30,000	
Wooded Area Access	8.50	ACRE	$8,000.00	$68,000	
Subtotal					$268,000
Site Work					
Excavating/Load (On-Site)	20,000.00	CY	$15.00	$300,000	
Excavating/Load (Off-Site)	1,000.00	CY	$15.00	$15,000	
Haul Off-Site (3), Non-Haz. Waste	14,100.00	CY	$20.00	$282,000	
Haul Off-Site (3), Haz. Waste	10,000.00	CY	$50.00	$500,000	
Dispose Off-Site Land Disposable Haz. Waste	5,000.00	CY	$285.00	$1,425,000	
Dispose Off-Site Non-Haz. Waste	14,100.00	CY	$75.00	$1,057,500	
Treat & Dispose Off-Site Non-Land Disposable Haz. W	5,000.00	CY	$385.00	$1,925,000	
Comfirmational Sampling	25.00	EA	$100.00	$2,500	
Subtotal					$5,507,000
On-Site Restoration					
Topsoil/Fill	16,000.00	CY	$20.00	$320,000	
Earthwork	19.00	ACRE	$5,000.00	$95,000	
Hydroseed	13.00	ACRE	$3,500.00	$45,500	
Wetlands Vegetation	6.00	ACRE	$15,000.00	$90,000	
Subtotal					$551,000
Off-Site Restoration					
Topsoil/Fill	2,100.00	CY	$20.00	$42,000	
Earthwork	2.50	ACRE	$5,000.00	$12,500	
Wetlands Vegetation	2.50	ACRE	$15,000.00	$37,500	
Subtotal					$92,000
TOTAL DIRECT CAPITAL COSTS					$6,418,000
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$1,605,000	
Engineering (15% +/-)				$963,000	
Administration (5% +/-)				$321,000	
TOTAL INDIRECT CAPITAL COSTS					$2,889,000
TOTAL ESTIMATED REMEDIAL COST					$9,307,000

Notes:

1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget cost only.
3. Includes excavated soil and excavated sediment.
4. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

Table 18 5/12/93

NL Industries, Inc. Site

Soil Alternative G (500 ppm) - Cost Estimate (1,4)

EXCAVATION/OFF-SITE DISPOSAL

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total C
DIRECT CAPITAL COSTS					
Site Preparation					
Mobilization/Site Prep.	1.00	LS	$150,000.00	$150,000	
Health and Safety Plan	1.00	LS	$20,000.00	$20,000	
Erosion/Sediment/Dust Control	1.00	LS	$30,000.00	$30,000	
Wooded Area Access	15.00	ACRE	$8,000.00	$120,000	
Subtotal					$320,000
Site Work					
Excavating/Load (On-Site)	28,000.00	CY	$15.00	$420,000	
Excavating/Load (Off-Site)	1,800.00	CY	$15.00	$27,000	
Haul Off-Site (3), Non-Haz. Waste	25,800.00	CY	$20.00	$516,000	
Haul Off-Site (3), Haz. Waste	10,000.00	CY	$50.00	$500,000	
Dispose Off-Site Land Disposable Haz. Waste	5,000.00	CY	$285.00	$1,425,000	
Dispose Off-Site Non-Haz. Waste	25,800.00	CY	$75.00	$1,935,000	
Treat & Dispose Off-Site Non-Land Disposable Haz	5,000.00	CY	$385.00	$1,925,000	
Comfirmational Sampling	33.00	EA	$100.00	$3,300	
Subtotal					$6,751,300
On-Site Restoration					
Topsoil/Fill	22,000.00	CY	$20.00	$440,000	
Earthwork	27.00	ACRE	$5,000.00	$135,000	
Hydroseed	15.00	ACRE	$3,500.00	$52,500	
Wetlands Vegetation	12.00	ACRE	$15,000.00	$180,000	
Subtotal					$808,0
Off-Site Restoration					
Topsoil/Fill	2,450.00	CY	$20.00	$49,000	
Earthwork	3.00	ACRE	$5,000.00	$15,000	
Wetlands Vegetation	3.00	ACRE	$15,000.00	$45,000	
Subtotal					$109,000
TOTAL DIRECT CAPITAL COSTS					$7,988,000
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$1,997,000	
Engineering (15% +/-)				$1,198,000	
Administration (5% +/-)				$399,000	
TOTAL INDIRECT CAPITAL COSTS					$3,594,000
TOTAL ESTIMATED REMEDIAL COST					**$11,582,000**

Notes:

1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. *Line items provided to form budget cost only.*
3. Includes excavated sediment.
4. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of *technical alternatives.*

NLI 002 0788

Table 18.1
NL Industries, Inc. Site
Soil Alternative H – Cost Estimate (1,5)
EXCAVATION OF ON-SITE SOILS OVER 1,000 ppm LEAD AND OFFSITE & WETLAND SOILS OVER 500 ppm LEAD/
TREATMENT OF EXCAVATED SOILS REQUIRING TREATMENT/ON-SITE CONSOLIDATION/DISPOSAL

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation					
Mobilization/Site Prep.	1.00	LS	$500,000.00	$500,000	
Road Relocation	1.00	LS	$35,000.00	$35,000	
Health and Safety Plan	1.00	LS	$20,000.00	$20,000	
Erosion/Sediment/Dust Control	1.00	LS	$50,000.00	$50,000	
Wooded Area Access	8.50	ACRE	$8,000.00	$68,000	
Treatability Testing	1.00	LS	$150,000.00	$150,000	
Subtotal					$823,000
Site Work					
Excavating/Load (On-Site)	21,500.00	CY	$15.00	$322,500	
Excavating/Load (Off-Site)	6,000.00	CY	$15.00	$90,000	
Truck Haul (4)	33,300.00	CY	$5.00	$166,500	
Confirmational Sampling	25.00	EA	$100.00	$2,500	
Subtotal					$581,500
On-Site Restoration (3)					
Topsoil/Fill	11,500.00	CY	$20.00	$230,000	
Earthwork	19.00	ACRE	$5,000.00	$95,000	
Hydroseed	13.00	ACRE	$3,500.00	$45,500	
Wetlands Vegetation	6.00	ACRE	$15,000.00	$90,000	
Subtotal					$460,500
Off-Site Restoration (3)					
Topsoil/Fill	2,450.00	CY	$20.00	$49,000	
Earthwork	3.00	ACRE	$5,000.00	$15,000	
Wetlands Vegetation	3.00	ACRE	$15,000.00	$45,000	
Subtotal					$109,000
On-Site Consolidation Pile					
Surface Prep/Cap Base Grading	5,200.00	CY	$5.00	$26,000	
Disposal Soil Grading (4)	22,300.00	CY	$5.00	$111,500	
40 mil VLDPE Geomembrane	56,000.00	SF	$1.00	$56,000	
Drainage Layer (6")	1,000.00	CY	$10.00	$10,000	
Root Zone Soil (24" Layer)	4,200.00	CY	$15.00	$63,000	
Topsoil (6" layer)	1,000.00	CY	$20.00	$20,000	
Seed, Fertilize, and Mulch	1.30	ACRE	$5,000.00	$6,500	
Liner System	1.00	LS	$550,000.00	$550,000	
Subtotal					$843,000
Soil Washing/Disposal					
Soil Washing	5,500.00	CY	$200.00	$1,100,000	
Haul & Backfill Clean Soil	3,500.00	CY	$5.00	$17,500	
Solidify Fines	2,000.00	CY	$100.00	$200,000	
Haul Fines Off-Site	3,000.00	CY	$50.00	$150,000	
Dispose Fines Off-Site	3,000.00	CY	$100.00	$300,000	
Haul Off-Site	5,500.00	CY	$50.00	$275,000	
Disposal Off-Site	5,500.00	CY	$285.00	$1,567,500	
Bench Scale/Full Scale Demonstration	1.00	LS	$100,000.00	$100,000	
Subtotal					$3,710,000
TOTAL DIRECT CAPITAL COSTS					$6,527,000
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$1,632,000	
Engineering (15% +/-)				$979,000	
Administration (5% +/-)				$326,000	
Permitting				$100,000	
TOTAL INDIRECT CAPITAL COSTS					$3,037,000
TOTAL CAPITAL COSTS					$9,564,000
ANNUAL MAINTENANCE COSTS					
Cap Maintenance	1.00	LS	$5,000.00	$5,000	
TOTAL ANNUAL COSTS					$5,000
PRESENT WORTH (30 YR @ 5%)					$77,000
TOTAL ESTIMATED REMEDIAL COST					$9,641,000

Notes:
1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget cost only.
3. Restoration includes regrading excavated areas and installation of 6 inches of topsoil to establish vegetation.
4. Includes 1,500 CY of stream sediment.
5. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

NL Industries, Inc. Site

Ground Water Alternative A - Cost Estimate (1,3)

NO ACTION

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cos.
DIRECT CAPTIAL COSTS					
Institutional Controls	1.00	LS	$10,000	$10,000	
TOTAL CAPITAL COSTS					$10,000
ANNUAL OPERATING AND MAINTENANCE COSTS					
Ground Water Monitoring Program					
Mobilization	1.00	LS	$500	$500	
Sampling Equipment	1.00	LS	$250	$250	
Sampler	16.00	Manhours	$50	$800	
Shipping	2.00	EA	$70	$140	
Analysis	10.00	Samples	$100	$1,000	
Analysis (QA/QC)	2.00	Samples	$100	$200	
Report	60.00	Manhours	$60	$3,600	
Subtotal (Biennial Cost)				$6,490	
Annual Cost					$3,245
TOTAL ANNUAL O&M					$3,245
PRESENT WORTH (30 YR @ 5%)					$50,000
TOTAL ESTIMATED REMEDIAL COST					$60,00

Notes:

1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget estimate only.
3. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

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Table 20

NL Industries, Inc. Site
Ground Water Alternative B - Cost Estimate (1,4)
PUMP AND TREAT SUBSURFACE DISCHARGE
VIA INFILTRATION POND

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation					
Mobilization/Site Prep.	1.00	LS	$200,000	$200,000	
Health and Safety Plan	1.00	LS	$20,000	$20,000	
Erosion/Sediment/Dust Control	1.00	LS	$30,000	$30,000	
Clear and Grub	11.00	ACRE	$8,000	$88,000	
Well Point System Start-up	1.00	LS	$15,000	$15,000	
Subtotal					$353,000
Purchased Treatment Plant Equipment (E)					
GW Recovery Pump (75 GPM)	4.00	EA	$2,500	$10,000	
Equalization Tank (60,000 Gal)	1.00	EA	$23,000	$23,000	
Clarifier Feed Pump (125 GPM)	3.00	EA	$3,500	$10,500	
Mix Tank (5000 Gal)	1.00	EA	$4,000	$4,000	
Clarifier (250 GPM)	1.00	EA	$100,000	$100,000	
Lime Feed System	1.00	LS	$14,000	$14,000	
Chemical Feed Systems	1.00	LS	$8,000	$8,000	
Filter Feed Sump Tank (5000 Gal)	1.00	EA	$4,000	$4,000	
Filter Feed Pump (125 GPM)	3.00	EA	$3,500	$10,500	
Multi Media Filter	1.00	EA	$40,000	$40,000	
Treated Water Tank (30,000 Gal)	1.00	EA	$12,000	$12,000	
Backwash Pump (500 GPM)	2.00	EA	$4,000	$8,000	
Sludge Transfer System	1.00	EA	$6,000	$6,000	
Sludge Thickener	1.00	EA	$6,000	$6,000	
Decant Pump (50 GPM)	1.00	EA	$1,000	$1,000	
Filter Press (.5 ton/day)	1.00	EA	$27,000	$27,000	
Filtrate Pump (10 GPM)	1.00	EA	$700	$700	
Ion Exchange Columns, Regen., Tanks, Pumps	1.00	LS	$75,000	$75,000	
Subtotal (E)					$359,700
Treatment Plant Components	% of (E)				
Installation	47.00			$169,059	
Instrumentation and Controls	18.00			$64,746	
Piping	66.00			$237,402	
Electrical	11.00			$39,567	
Building and Site Improvements	28.00			$100,716	
Services / Utilities	70.00			$251,790	
Subtotal					$863,280
Reverse Osmosis Equipment	1.00	LS	$750,000	$750,000	$750,000
VOC Pretreatment (MW-11)					
Recovery Well w/pump	1.00	EA	$20,000	$20,000	
Air Stripper w/ sump tank and pump	1.00	EA	$25,000	$25,000	
Cartridge Filter Module	2.00	EA	$5,000	$10,000	
Piping	500.00	LF	$20	$10,000	
Electrical	1.00	LS	$15,000	$15,000	
Pad/Building	1.00	LS	$25,000	$25,000	
Subtotal					$105,000
Infiltration Pond (3)					
Earthwork	10.00	ACRE	$5,000	$50,000	
Discharge Piping	1,200.00	FT	$30	$36,000	
Piping End Treatments	2.00	EA	$7,500	$15,000	
Vegetation	10.00	ACRE	$15,000	$150,000	
Subtotal					$251,000
TOTAL DIRECT CAPITAL COSTS					**$2,682,000**
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$671,000	
Engineering (15% +/-)				$402,000	
Administration (5% +/-)				$134,000	
TOTAL INDIRECT CAPITAL COSTS					**$1,207,000**
TOTAL CAPITAL COSTS					**$3,889,000**

NLI 002 0791

NL Industries, Inc. Site
Ground Water Alternative B - Cost Estimate (1,4)
PUMP AND TREAT SUBSURFACE DISCHARGE
VIA INFILTRATION POND

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
ANNUAL OPERATING AND MAINTENANCE COSTS					
Treatment Plant Operation					
Operating Labor	3,120.00	Manhour	$35	$109,200	
Maintenance (6% Total Capital)	1.00	LS	$233,340	$233,340	
Pond Maintenance	1.00	LS	$5,000	$5,000	
Well Point System					
Inspection and Maintenance	1.00	LS	$10,000	$10,000	
Chemical Usage	1.00	LS	$75,000	$75,000	
Sludge Disposal	180.00	TON	$250	$45,000	
Ion Exchange Regen.					
Water Disposal	50,000.00	Gal.	$0.25	$12,500	
Electrical Requirement	200,000.00	KWH	$0.11	$22,000	
Quarterly Effluent Monitoring	4.00	EA	$2,000	$8,000	
Subtotal					$520,040
Ground Water Monitoring Program					
Mobilization	1.00	LS	$500	$500	
Sampling Equipment	1.00	LS	$250	$250	
Sampler	16.00	Manhour	$50	$800	
Shipping	2.00	EA	$70	$140	
Analysis	10.00	Samples	$100	$1,000	
Analysis (QA/QC)	2.00	Samples	$100	$200	
Report	60.00	Manhour	$60	$3,600	
Subtotal (Biennial Cost)				$6,490	
Annual Cost					$3,245
TOTAL ANNUAL O&M					$523,285
PRESENT WORTH (30 YR @ 5%)					$8,044,000
TOTAL ESTIMATED REMEDIAL COST					$11,933,000

Notes:
1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget estimate only. Design would require bench scale testing.
3. Land aquistion costs not included.
4. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

NL Industries, Inc. Site
Ground Water Alternative C - Cost Estimate (1,4)
PUMP AND TREAT SUBSURFACE DISCHARGE
VIA LEACH FIELD

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation					
Mobilization/Site Prep.	1.00	LS	$200,000	$200,000	
Health and Safety Plan	1.00	LS	$20,000	$20,000	
Erosion/Sediment/Dust Control	1.00	LS	$30,000	$30,000	
Clear and Grub	11.00	ACRE	$8,000	$88,000	
Well Point System Start-up	1.00	LS	$15,000	$15,000	
Subtotal					$353,000
Purchased Treatment Plant Equipment (E)					
GW Recovery Pump (75 GPM)	4.00	EA	$2,500	$10,000	
Equalization Tank (60,000 Gal)	1.00	EA	$23,000	$23,000	
Clarifier Feed Pump (125 GPM)	3.00	EA	$3,500	$10,500	
Mix Tank (5000 Gal)	1.00	EA	$4,000	$4,000	
Clarifier (250 GPM)	1.00	EA	$100,000	$100,000	
Lime Feed System	1.00	LS	$14,000	$14,000	
Chemical Feed Systems	1.00	LS	$8,000	$8,000	
Filter Feed Sump Tank (5000 Gal)	1.00	EA	$4,000	$4,000	
Filter Feed Pump (125 GPM)	3.00	EA	$3,500	$10,500	
Multi Media Filter	1.00	EA	$40,000	$40,000	
Treated Water Tank (30,000 Gal)	1.00	EA	$12,000	$12,000	
Backwash Pump (500 GPM)	2.00	EA	$4,000	$8,000	
Sludge Transfer System	1.00	EA	$6,000	$6,000	
Sludge Thickener	1.00	EA	$6,000	$6,000	
Decant Pump (50 GPM)	1.00	EA	$1,000	$1,000	
Filter Press (.5 ton/day)	1.00	EA	$27,000	$27,000	
Filtrate Pump (10 GPM)	1.00	EA	$700	$700	
Ion Exchange Columns, Regen., Tanks, Pumps	1.00	LS	$75,000	$75,000	
Subtotal (E)					$359,700
Treatment Plant Components	% of (E)				
Installation	47.00			$169,059	
Instrumentation and Controls	18.00			$64,746	
Piping	66.00			$237,402	
Electrical	11.00			$39,567	
Building and Site Improvements	28.00			$100,716	
Services / Utilities	70.00			$251,790	
Subtotal					$863,280
Reverse Osmosis Equipment	1.00	LS	$750,000	$750,000	$750,000
VOC Pretreatment (MW-11)					
Recovery Well w/pump	1.00	EA	$20,000	$20,000	
Air Stripper w/ sump tank and pump	1.00	EA	$25,000	$25,000	
Cartridge Filter Module	2.00	EA	$5,000	$10,000	
Piping	500.00	LF	$20	$10,000	
Electrical	1.00	LS	$15,000	$15,000	
Pad/Building	1.00	LS	$25,000	$25,000	
Subtotal					$105,000
Leach Field (3)					
Site Characteristics	1.00	L.S.	$15,000	$15,000	
Earth Work	30.00	ACRE	$4,600	$138,000	
Filter Bed	30.00	ACRE	$13,200	$396,000	
Perforated Pipe	30.00	ACRE	$3,000	$90,000	
Subtotal					$639,000
TOTAL DIRECT CAPITAL COSTS					$3,070,000
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$768,000	
Engineering (15% +/-)				$461,000	
Administration (5% +/-)				$154,000	
TOTAL INDIRECT CAPITAL COSTS					$1,383,000
TOTAL CAPITAL COSTS					$4,453,000

NL Industries, Inc. Site
Ground Water Alternative C - Cost Estimate (1,4)
PUMP AND TREAT SUBSURFACE DISCHARGE
VIA LEACH FIELD

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
ANNUAL OPERATING AND MAINTENANCE COSTS					
Treatment Plant Operation					
Operating Labor	3,120.00	Manhour	$35	$109,200	
Maintenance (6% Total Capital)	1.00	LS	$267,180	$267,180	
Leach Field Maintenance	1.00	LS	$10,000	$10,000	
Well Point System					
Inspection and Maintenance	1.00	LS	$10,000	$10,000	
Chemical Usage	1.00	LS	$75,000	$75,000	
Sludge Disposal	180.00	TON	$250	$45,000	
Ion Exchange Regen.					
Water Disposal	50,000.00	Gal.	$0.25	$12,500	
Electrical Requirement	200,000.00	KWH	$0.11	$22,000	
Quarterly Effluent Monitoring	4.00	EA	$2,000	$8,000	
Subtotal					$558,880
Ground Water Monitoring Program					
Mobilization	1.00	LS	$500	$500	
Sampling Equipment	1.00	LS	$250	$250	
Sampler	16.00	Manhour	$50	$800	
Shipping	2.00	EA	$70	$140	
Analysis	10.00	Samples	$100	$1,000	
Analysis (QA/QC)	2.00	Samples	$100	$200	
Report	60.00	Manhour	$60	$3,600	
Subtotal (Biennial Cost)				$6,490	
Annual Cost					$3,245
TOTAL ANNUAL O&M					**$562,125**
PRESENT WORTH (30 YR @ 5%)					**$8,641,000**
TOTAL ESTIMATED REMEDIAL COST					**$13,094,000**

Notes:
1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget estimate only. Design would require bench scale testing.
3. Land aquistion costs not included.
4. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

Table 22 7/12/93

NL Industries, Inc. Site

Ground Water Alternative D - Cost Estimate (1,4)

PUMP AND TREAT SUBSURFACE DISCHARGE

VIA INFILTRATION TRENCHES

Items (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation					
Mobilization/Site Prep.	1.00	LS	$200,000	$200,000	
Health and Safety Plan	1.00	LS	$20,000	$20,000	
Erosion/Sediment/Dust Control	1.00	LS	$30,000	$30,000	
Clear and Grub	11.00	ACRE	$8,000	$88,000	
Well Point System Start-up	1.00	LS	$15,000	$15,000	
Subtotal					$353,000
Purchased Treatment Plant Equipment (E)					
GW Recovery Pump (75 GPM)	4.00	EA	$2,500	$10,000	
Equalization Tank (60,000 Gal)	1.00	EA	$23,000	$23,000	
Clarifier Feed Pump (125 GPM)	3.00	EA	$3,500	$10,500	
Mix Tank (5000 Gal)	1.00	EA	$4,000	$4,000	
Clarifier (250 GPM)	1.00	EA	$100,000	$100,000	
Lime Feed System	1.00	LS	$14,000	$14,000	
Chemical Feed Systems	1.00	LS	$8,000	$8,000	
Filter Feed Sump Tank (5000 Gal)	1.00	EA	$4,000	$4,000	
Filter Feed Pump (125 GPM)	3.00	EA	$3,500	$10,500	
Multi Media Filter	1.00	EA	$40,000	$40,000	
Treated Water Tank (30,000 Gal)	1.00	EA	$12,000	$12,000	
Backwash Pump (500 GPM)	2.00	EA	$4,000	$8,000	
Sludge Transfer System	1.00	EA	$6,000	$6,000	
Sludge Thickener	1.00	EA	$6,000	$6,000	
Decant Pump (50 GPM)	1.00	EA	$1,000	$1,000	
Filter Press (.5 ton/day)	1.00	EA	$27,000	$27,000	
Filtrate Pump (10 GPM)	1.00	EA	$700	$700	
Ion Exchange Columns, Regen., Tanks, Pumps	1.00	LS	$75,000	$75,000	
Subtotal (E)					$359,700
Treatment Plant Components	% of (E)				
Installation	47.00			$169,059	
Instrumentation and Controls	18.00			$64,746	
Piping	66.00			$237,402	
Electrical	11.00			$39,567	
Building and Site Improvements	28.00			$100,716	
Services / Utilities	70.00			$251,790	
Subtotal					$863,280
Reverse Osmosis Equipment	1.00	LS	$750,000	$750,000	$750,000
VOC Pretreatment (MW-11)					
Recovery Well w/pump	1.00	EA	$20,000	$20,000	
Air Stripper w/ sump tank and pump	1.00	EA	$25,000	$25,000	
Cartridge Filter Module	2.00	EA	$5,000	$10,000	
Piping	500.00	LF	$20	$10,000	
Electrical	1.00	LS	$15,000	$15,000	
Pad/Building	1.00	LS	$25,000	$25,000	
Subtotal					$105,000
Infiltration Trench (3)					
Site Characteristics	1.00	L.S.	$15,000	$15,000	
Earth Work	20.00	ACRE	$5,000	$100,000	
Trench Filter Bed	1,000.00	CY	$200	$200,000	
Subtotal					$315,000
TOTAL DIRECT CAPITAL COSTS					$2,746,000
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$687,000	
Engineering (15% +/-)				$412,000	
Administration (5% +/-)				$137,000	
TOTAL INDIRECT CAPITAL COSTS					$1,236,000
TOTAL CAPITAL COSTS					$3,982,000

NLI 002 0795

NL Industries, Inc. Site
Ground Water Alternative D - Cost Estimate (1,4)
PUMP AND TREAT SUBSURFACE DISCHARGE
VIA INFILTRATION TRENCHES

Items (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
ANNUAL OPERATING AND MAINTENANCE COSTS					
Treatment Plant Operation					
Operating Labor	3,120.00	Manhour	$35	$109,200	
Maintenance (6% Total Capital)	1.00	LS	$238,920	$238,920	
Trench Maintenance	1.00	LS	$5,000	$5,000	
Well Point System					
Inspection and Maintenance	1.00	LS	$10,000	$10,000	
Chemical Usage	1.00	LS	$75,000	$75,000	
Sludge Disposal	180.00	TON	$250	$45,000	
Ion Exchange Regen.					
Water Disposal	50,000.00	Gal.	$0.25	$12,500	
Electrical Requirement	200,000.00	KWH	$0.11	$22,000	
Quarterly Effluent Monitoring	4.00	EA	$2,000	$8,000	
Subtotal					$525,620
Ground Water Monitoring Program					
Mobilization	1.00	LS	$500	$500	
Sampling Equipment	1.00	LS	$250	$250	
Sampler	16.00	Manhour	$50	$800	
Shipping	2.00	EA	$70	$140	
Analysis	10.00	Samples	$100	$1,000	
Analysis (QA/QC)	2.00	Samples	$100	$200	
Report	60.00	Manhour	$60	$3,600	
Subtotal (Biennial Cost)				$6,490	
Annual Cost					$3,245
TOTAL ANNUAL O&M					**$528,865**
PRESENT WORTH (30 YR @ 5%)					**$8,130,000**
TOTAL ESTIMATED REMEDIAL COST					**$12,112,000**

Notes:
1. Cost estimate based on R.S. Means 1990 *Construction Cost Data*, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget estimate only. Design would require bench scale testing.
3. Land aquistion costs not included.
4. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

NLI 002 0796

Table 23 7/12/93

NL Industries, Inc. Site
Ground Water Alternative E - Cost Estimate (1,3)
PUMP AND TREAT SUBSURFACE DISCHARGE
VIA REINJECTION WELLS TO UNCONFINED AQUIFER

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation					
Mobilization/Site Prep.	1.00	LS	$200,000	$200,000	
Health and Safety Plan	1.00	LS	$20,000	$20,000	
Erosion/Sediment/Dust Control	1.00	LS	$30,000	$30,000	
Clear and Grub	11.00	ACRE	$8,000	$88,000	
Well Point System Start-up	1.00	LS	$15,000	$15,000	
Subtotal					$353,000
Purchased Treatment Plant Equipment (E)					
GW Recovery Pump (75 GPM)	4.00	EA	$2,500	$10,000	
Equalization Tank (60,000 Gal)	1.00	EA	$23,000	$23,000	
Clarifier Feed Pump (125 GPM)	3.00	EA	$3,500	$10,500	
Mix Tank (5000 Gal)	1.00	EA	$4,000	$4,000	
Clarifier (250 GPM)	1.00	EA	$100,000	$100,000	
Lime Feed System	1.00	LS	$14,000	$14,000	
Chemical Feed Systems	1.00	LS	$8,000	$8,000	
Filter Feed Sump Tank (5000 Gal)	1.00	EA	$4,000	$4,000	
Filter Feed Pump (125 GPM)	3.00	EA	$3,500	$10,500	
Multi Media Filter	1.00	EA	$40,000	$40,000	
Treated Water Tank (30,000 Gal)	1.00	EA	$12,000	$12,000	
Backwash Pump (500 GPM)	2.00	EA	$4,000	$8,000	
Sludge Transfer System	1.00	EA	$6,000	$6,000	
Sludge Thickener	1.00	EA	$6,000	$6,000	
Decant Pump (50 GPM)	1.00	EA	$1,000	$1,000	
Filter Press (.5 ton/day)	1.00	EA	$27,000	$27,000	
Filtrate Pump (10 GPM)	1.00	EA	$700	$700	
Ion Exchange Columns, Regen., Tanks, Pumps	1.00	LS	$75,000	$75,000	
Subtotal (E)					$359,700
Treatment Plant Components	% of (E)				
Installation	47.00			$169,059	
Instrumentation and Controls	18.00			$64,746	
Piping	66.00			$237,402	
Electrical	11.00			$39,567	
Building and Site Improvements	28.00			$100,716	
Services / Utilities	70.00			$251,790	
Subtotal					$863,280
Reverse Osmosis Equipment	1.00	LS	$750,000	$750,000	$750,000
VOC Pretreatment (MW-11)					
Recovery Well w/pump	1.00	EA	$20,000	$20,000	
Air Stripper w/ sump tank and pump	1.00	EA	$25,000	$25,000	
Cartridge Filter Module	2.00	EA	$5,000	$10,000	
Piping	500.00	LF	$20	$10,000	
Electrical	1.00	LS	$15,000	$15,000	
Pad/Building	1.00	LS	$25,000	$25,000	
Subtotal					$105,000
Discharge To Unconfined Aquifer Through Reinjection Wells					
Site Characteristics	1.00	L.S.	$10,000	$10,000	
Injection Wells	15.00	WELL	$7,500	$112,500	
Piping	4,000.00	FT	$5	$20,000	
Subtotal					$142,500
TOTAL DIRECT CAPITAL COSTS					$2,573,000
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$643,000	
Engineering (15% +/-)				$386,000	
Administration (5% +/-)				$129,000	
TOTAL INDIRECT CAPITAL COSTS					$1,158,000
TOTAL CAPITAL COSTS					$3,731,000

NLI 002 0797

NL Industries, Inc. Site
Ground Water Alternative E - Cost Estimate (1,3)
PUMP AND TREAT SUBSURFACE DISCHARGE
VIA REINJECTION WELLS TO UNCONFINED AQUIFER

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
ANNUAL OPERATING AND MAINTENANCE COSTS					
Treatment Plant Operation					
Operating Labor	3,120.00	Manhour	$35	$109,200	
Maintenance (6% Total Capital)	1.00	LS	$223,860	$223,860	
Reinjection Well Maintenance	15.00	WELL	$2,000	$30,000	
Well Point System					
Inspection and Maintenance	1.00	LS	$10,000	$10,000	
Chemical Usage	1.00	LS	$75,000	$75,000	
Sludge Disposal	180.00	TON	$250	$45,000	
Ion Exchange Regen.					
Water Disposal	50,000.00	Gal.	$0.25	$12,500	
Electrical Requirement	200,000.00	KWH	$0.11	$22,000	
Quarterly Effluent Monitoring	4.00	EA	$2,000	$8,000	
Subtotal					$535,560
Ground Water Monitoring Program					
Mobilization	1.00	LS	$500	$500	
Sampling Equipment	1.00	LS	$250	$250	
Sampler	16.00	Manhour	$50	$800	
Shipping	2.00	EA	$70	$140	
Analysis	15.00	Samples	$100	$1,500	
Analysis (QA/QC)	2.00	Samples	$100	$200	
Report	60.00	Manhour	$60	$3,600	
Subtotal (Biennial Cost)				$6,990	
Annual Cost					$3,495
TOTAL ANNUAL O&M					**$539,055**
PRESENT WORTH (30 YR @ 5%)					**$8,286,000**
TOTAL ESTIMATED REMEDIAL COST					**$12,017,000**

Notes:
1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget estimate only. Design would require bench scale testing.
3. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

TABLE 24 7/12/93

NL Industries, Inc. Site
Ground Water Alternative F - Cost Estimate (1,3)
PUMP AND TREAT SUBSURFACE DISCHARGE
VIA REINJECTION WELLS TO CONFINED AQUIFER

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation					
Mobilization/Site Prep.	1.00	LS	$200,000	$200,000	
Health and Safety Plan	1.00	LS	$20,000	$20,000	
Erosion/Sediment/Dust Control	1.00	LS	$30,000	$30,000	
Clear and Grub	11.00	ACRE	$8,000	$88,000	
Well Point System Start-up	1.00	LS	$15,000	$15,000	
Subtotal					$353,000
Purchased Treatment Plant Equipment (E)					
GW Recovery Pump (75 GPM)	4.00	EA	$2,500	$10,000	
Equalization Tank (60,000 Gal)	1.00	EA	$23,000	$23,000	
Clarifier Feed Pump (125 GPM)	3.00	EA	$3,500	$10,500	
Mix Tank (5000 Gal)	1.00	EA	$4,000	$4,000	
Clarifier (250 GPM)	1.00	EA	$100,000	$100,000	
Lime Feed System	1.00	LS	$14,000	$14,000	
Chemical Feed Systems	1.00	LS	$8,000	$8,000	
Filter Feed Sump Tank (5000 Gal)	1.00	EA	$4,000	$4,000	
Filter Feed Pump (125 GPM)	3.00	EA	$3,500	$10,500	
Multi Media Filter	1.00	EA	$40,000	$40,000	
Treated Water Tank (30,000 Gal)	1.00	EA	$12,000	$12,000	
Backwash Pump (500 GPM)	2.00	EA	$4,000	$8,000	
Sludge Transfer System	1.00	EA	$6,000	$6,000	
Sludge Thickener	1.00	EA	$6,000	$6,000	
Decant Pump (50 GPM)	1.00	EA	$1,000	$1,000	
Filter Press (.5 ton/day)	1.00	EA	$27,000	$27,000	
Filtrate Pump (10 GPM)	1.00	EA	$700	$700	
Ion Exchange Columns, Regen., Tanks, Pumps	1.00	LS	$75,000	$75,000	
Subtotal (E)					$359,700
Treatment Plant Components	% of (E)				
Installation	47.00			$169,059	
Instrumentation and Controls	18.00			$64,746	
Piping	66.00			$237,402	
Electrical	11.00			$39,567	
Building and Site Improvements	28.00			$100,716	
Services / Utilities	70.00			$251,790	
Subtotal					$863,280
Reverse Osmosis Equipment	1.00	LS	$750,000	$750,000	$750,000
VOC Pretreatment (MW-11)					
Recovery Well w/pump	1.00	EA	$20,000	$20,000	
Air Stripper w/ sump tank and pump	1.00	EA	$25,000	$25,000	
Cartridge Filter Module	2.00	EA	$5,000	$10,000	
Piping	500.00	LF	$20	$10,000	
Electrical	1.00	LS	$15,000	$15,000	
Pad/Building	1.00	LS	$25,000	$25,000	
Subtotal					$105,000
Discharge To Confined Aquifer Through Reinjection Wells					
Site Characteristics	1.00	L.S.	$10,000	$10,000	
Injection Wells	5.00	WELL	$15,000	$75,000	
Piping	2,000.00	FT	$5	$10,000	
Subtotal					$95,000
TOTAL DIRECT CAPITAL COSTS					**$2,526,000**
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$632,000	
Engineering (15% +/-)				$379,000	
Administration (5% +/-)				$126,000	
TOTAL INDIRECT CAPITAL COSTS					**$1,137,000**
TOTAL CAPITAL COSTS					**$3,663,000**

NL I 002 0799

NL Industries, Inc. Site
Ground Water Alternative F - Cost Estimate (1,3)
PUMP AND TREAT SUBSURFACE DISCHARGE
VIA REINJECTION WELLS TO CONFINED AQUIFER

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
ANNUAL OPERATING AND MAINTENANCE COSTS					
Treatment Plant Operation					
Operating Labor	3,120.00	Manhour	$35	$109,200	
Maintenance (6% Total Capital)	1.00	LS	$219,780	$219,780	
Reinjection Well Maintenance	5.00	WELL	$1,000	$5,000	
Well Point System					
Inspection and Maintenance	1.00	LS	$10,000	$10,000	
Chemical Usage	1.00	LS	$75,000	$75,000	
Sludge Disposal	180.00	TON	$250	$45,000	
Ion Exchange Regen.					
Water Disposal	50,000.00	Gal.	$0.25	$12,500	
Electrical Requirement	200,000.00	KWH	$0.11	$22,000	
Quarterly Effluent Monitoring	4.00	EA	$2,000	$8,000	
Subtotal					$506,480
Ground Water Monitoring Program					
Mobilization	1.00	LS	$500	$500	
Sampling Equipment	1.00	LS	$250	$250	
Sampler	16.00	Manhour	$50	$800	
Shipping	2.00	EA	$70	$140	
Analysis	10.00	Samples	$100	$1,000	
Analysis (QA/QC)	2.00	Samples	$100	$200	
Report	60.00	Manhour	$60	$3,600	
Subtotal (Biennial Cost)				$6,490	
Annual Cost					$3,245
TOTAL ANNUAL O&M					$509,725
PRESENT WORTH (30 YR @ 5%)					$7,835,000
TOTAL ESTIMATED REMEDIAL COST					$11,498,000

Notes:
1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget estimate only. Design would require bench scale testing.
3. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

NLI 002 0800

Table 25 6/22/93

NL Industries, Inc. Site

Ground Water Alternative G - Cost Estimate (1,3)

PUMP AND TREAT WITH DIRECT DISCHARGE TO EAST/WEST STREAMS

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation					
Mobilization/Site Prep.	1.00	LS	$150,000	$150,000	
Health and Safety Plan	1.00	LS	$20,000	$20,000	
Erosion/Sediment/Dust Control	1.00	LS	$15,000	$15,000	
Clear and Grub	2.00	ACRE	$8,000	$16,000	
Well Point System Start-up	1.00	LS	$15,000	$15,000	
Subtotal					$216,000
Purchased Treatment Plant Equipment (E)					
GW Recovery Pump (75 GPM)	4.00	EA	$2,500	$10,000	
Equalization Tank (60,000 Gal)	1.00	EA	$23,000	$23,000	
Clarifier Feed Pump (125 GPM)	3.00	EA	$3,500	$10,500	
Mix Tank (5000 Gal)	1.00	EA	$4,000	$4,000	
Clarifier (250 GPM)	1.00	EA	$100,000	$100,000	
Lime Feed System	1.00	LS	$14,000	$14,000	
Chemical Feed Systems	1.00	LS	$8,000	$8,000	
Filter Feed Sump Tank (5000 Gal)	1.00	EA	$4,000	$4,000	
Filter Feed Pump (125 GPM)	3.00	EA	$3,500	$10,500	
Multi Media Filter	1.00	EA	$40,000	$40,000	
Treated Water Tank (30,000 Gal)	1.00	EA	$12,000	$12,000	
Backwash Pump (500 GPM)	2.00	EA	$4,000	$8,000	
Sludge Transfer System	1.00	EA	$6,000	$6,000	
Sludge Thickener	1.00	EA	$6,000	$6,000	
Decant Pump (50 GPM)	1.00	EA	$1,000	$1,000	
Filter Press (.5 ton/day)	1.00	EA	$27,000	$27,000	
Filtrate Pump (10 GPM)	1.00	EA	$700	$700	
Ion Exchange Columns, Regen., Tanks, Pumps	1.00	LS	$150,000	$150,000	
Subtotal (E)					$434,700
Reverse Osmosis Equipment for streams dicharge	1.00	LS	$750,000	$750,000	
Subtotal					$750,000
Treatment Plant Components	% of (E)				
Installation	47.00			$204,309	
Instrumentation and Controls	18.00			$78,246	
Piping	66.00			$286,902	
Electrical	11.00			$47,817	
Building and Site Improvements	28.00			$121,716	
Services / Utilities	70.00			$304,290	
Subtotal					$1,043,280
VOC Pretreatment (MW-11)					
Recovery Well w/pump	1.00	EA	$20,000	$20,000	
Air Stripper w/ sump tank and pump	1.00	EA	$25,000	$25,000	
Piping	500.00	LF	$20	$10,000	
Electrical	1.00	LS	$15,000	$15,000	
Pad/Building	1.00	LS	$25,000	$25,000	
Subtotal					$95,000
Discharge					
Piping	800.00	FT	$30	$24,000	
Earthwork	2.00	ACRE	$5,000	$10,000	
Piping End Treatments	1.00	EA	$7,500	$7,500	
Subtotal					$41,500
TOTAL DIRECT CAPITAL COSTS					$2,580,000
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$645,000	
Engineering (15% +/-)				$387,000	
Administration (5% +/-)				$129,000	
TOTAL INDIRECT CAPITAL COSTS					$1,161,000
TOTAL CAPITAL COSTS					$3,741,000

NLI 002 0801

NL Industries, Inc. Site
Ground Water Alternative G - Cost Estimate (1,3)
PUMP AND TREAT WITH DIRECT DISCHARGE TO EAST/WEST STREAMS

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
·UAL OPERA ·IG AND MAINTENANCE COSTS					
·eatment Plant Operation					
Operating Labor	2,000.00	Manhour	$35	$70,000	
Maintenance (6% Total Capital)	1.00	LS	$224,460	$224,460	
Well Point System					
Inspection anc ·intenance	1.00	LS	$10,000	$10,000	
Outfall Pipeline					
Inspection an· ·intenance	1.00	LS	$3,000	$3,000	
Chemical Usage	1.00	LS	$100,000	$100,000	
Sludge Disposal	1?0.00	TON	$250	$45,000	
Ion Exchange Regen.					
Water Disposal	100,[illegible].00	Gal.	$0.25	$25,000	
Electrical Requirement	200,000.00	KWH	$0.11	$22,000	
Quarterly Effluent Monitoring	4.00	EA	$2,000	$8,000	
Subtotal					$507,460
Ground Water Monitoring Program					
Mobilization	1.00	LS	$500	$500	
Sampling Equipment	1.00	LS	$250	$250	
Sampler	16.00	Manhour	$50	$800	
Shipping	2.00	EA	$70	$140	
Analysis	10.00	Samples	$100	$1,000	
Analysis (QA/QC)	2.00	Samples	$100	$200	
Report	60.00	Manhour	$60	$3,600	
Subtotal (Biennial Cost)				$6,490	
Annual Cost					$3,245
TOTAL ANNUAL O&M					$510,705
·ENT WORTH (30 YR @ 5%)					$7,851,000
TOTAL ESTIMATED REMEDIAL COST					$11,592,000

Notes:
1. Cost estimate based on R.S. Means 1990 Construction Cost Data, Vendor Quotations and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget estimate only. Design would require bench scale testing.
3. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

NLI 002 0802

Table 26 6/22/93

NL Industries, Inc. Site

Ground Water Alternative G - Cost Estimate (1,3)

PUMP AND TREAT WITH DIRECT DISCHARGE TO DELAWARE RIVER

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation					
Mobilization/Site Prep.	1.00	LS	$150,000	$150,000	
Health and Safety Plan	1.00	LS	$20,000	$20,000	
Erosion/Sediment/Dust Control	1.00	LS	$15,000	$15,000	
Clear and Grub	2.00	ACRE	$8,000	$16,000	
Well Point System Start-up	1.00	LS	$15,000	$15,000	
Subtotal					$216,000
Outfall Construction for Delaware River Discharge	1.00	LS	$600,000	$600,000	
Subtotal					$600,000
Purchased Treatment Plant Equipment (E)					
GW Recovery Pump (75 GPM)	4.00	EA	$2,500	$10,000	
Equalization Tank (60,000 Gal)	1.00	EA	$23,000	$23,000	
Clarifier Feed Pump (125 GPM)	3.00	EA	$3,500	$10,500	
Mix Tank (5000 Gal)	1.00	EA	$4,000	$4,000	
Clarifier (250 GPM)	1.00	EA	$100,000	$100,000	
Lime Feed System	1.00	LS	$14,000	$14,000	
Chemical Feed Systems	1.00	LS	$8,000	$8,000	
Filter Feed Sump Tank (5000 Gal)	1.00	EA	$4,000	$4,000	
Filter Feed Pump (125 GPM)	3.00	EA	$3,500	$10,500	
Multi Media Filter	1.00	EA	$40,000	$40,000	
Treated Water Tank (30,000 Gal)	1.00	EA	$12,000	$12,000	
Backwash Pump (500 GPM)	2.00	EA	$4,000	$8,000	
Sludge Transfer System	1.00	EA	$6,000	$6,000	
Sludge Thickener	1.00	EA	$6,000	$6,000	
Decant Pump (50 GPM)	1.00	EA	$1,000	$1,000	
Filter Press (.5 ton/day)	1.00	EA	$27,000	$27,000	
Filtrate Pump (10 GPM)	1.00	EA	$700	$700	
Ion Exchange Columns, Regen., Tanks, Pumps	1.00	LS	$150,000	$150,000	
Subtotal (E)					$434,700
Treatment Plant Components	% of (E)				
Installation	47.00			$204,309	
Instrumentation and Controls	18.00			$78,246	
Piping	66.00			$286,902	
Electrical	11.00			$47,817	
Building and Site Improvements	28.00			$121,716	
Services / Utilities	70.00			$304,290	
Subtotal					$1,043,280
VOC Pretreatment (MW-11)					
Recovery Well w/pump	1.00	EA	$20,000	$20,000	
Air Stripper w/ sump tank and pump	1.00	EA	$25,000	$25,000	
Piping	500.00	LF	$20	$10,000	
Electrical	1.00	LS	$15,000	$15,000	
Pad/Building	1.00	LS	$25,000	$25,000	
Subtotal					$95,000
Discharge					
Piping	800.00	FT	$30	$24,000	
Earthwork	2.00	ACRE	$5,000	$10,000	
Piping End Treatments	1.00	EA	$7,500	$7,500	
Subtotal					$41,500
TOTAL DIRECT CAPITAL COSTS					$2,430,000
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$608,000	
Engineering (15% +/-)				$365,000	
Administration (5% +/-)				$122,000	
TOTAL INDIRECT CAPITAL COSTS					$1,095,000
TOTAL CAPITAL COSTS					$3,525,000

NLI 002 0803

NL Industries, Inc. Site

Ground Water Alternative G - Cost Estimate (1,3)

PUMP AND TREAT WITH DIRECT DISCHARGE TO DELAWARE RIVER

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
ANNUAL OPERATING AND MAINTENANCE COSTS					
Treatment Plant Operation					
Operating Labor	2,000.00	Manhour	$35	$70,000	
Maintenance (4% Total Capital)	1.00	LS	$1[illegible]00	$141,000	
Well Point System					
Inspection and Maintenance	1.00	[illegible]	[illegible]0,000	$10,000	
Outfall Pipeline					
Inspection and Maintenance	1.00	LS	$3,000	$3,000	
Chemical Usage	1.00	LS	$100,000	$100,000	
Sludge Disposal	180.00	TON	$250	$45,000	
Ion Exchange Regen.					
Water Disposal	100,000.00	Ga	$0.25	$25,000	
Electrical Requirement	200,000.00	KV	$0.11	$22,000	
Quarterly Effluent Monitoring	4.00	EA	$2,000	$8,000	
Subtotal					**$424,000**
Ground Water Monitoring Program					
Mobilization	1.00	LS	$500	$500	
Sampling Equipment	1.00	LS	$250	$250	
Sampler	16.00	Manhour	$50	$800	
Shipping	2.00	EA	$70	$140	
Analysis	10.00	Samples	$100	$1,000	
Analysis (QA/QC)	2.00	Samples	$100	$200	
Report	60.00	Manhour	$60	$3,600	
Subtotal (Biennial Cost)				$6,490	
Annual Cost					**$3,24[illegible]**
TOTAL ANNUAL O&M					**$427,245**
PRESENT WORTH (30 YR @ 5%)					**$6,568,000**
TOTAL ESTIMATED REMEDIAL COST					**$10,093,000**

Notes:

1. Cost estimate based on R.S. Means 1990 Construction Cost Data, Vendor Quotations and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget estimate only. Design would require bench scale testing.
3. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

Table 27
NL Industries, Inc. Site
South of U.S. Route 130
Sediment Alternative A - Cost Estimate (1,3)
NO ACTION

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
ANNUAL OPERATING AND MAINTENANCE COSTS					
Surface Water Monitoring Program					
Mobilization	1.00	LS	$500	$500	
Sampling Equipment	1.00	LS	$150	$150	
Sampler	24.00	Manhours	$50	$1,200	
Shipping	2.00	EA	$70	$140	
Analysis	10.00	Samples	$100	$1,000	
Analysis (QA/QC)	2.00	Samples	$100	$200	
Report	60.00	Manhours	$60	$3,600	
Subtotal (Semi-Annual Cost)				$6,790	
Annual Cost					$13,580
TOTAL ANNUAL O&M					$13,580
PRESENT WORTH (30 YR @ 5%)					$209,000
TOTAL ESTIMATED REMEDIAL COST					$209,000

Notes:
1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget estimate only.
3. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

Table 28
NL Industries, Inc. Site
South of U.S. Route 130
Sediment Alternative B (1,000 ppm) - Cost Estimate (1,5)
TEMPORARY STREAM DIVERSION

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation (4)					
Mobilization/Site Prep.	1.00	LS	$100,000.00	$100,000	
Health and Safety Plan	1.00	LS	$20,000.00	$20,000	
Erosion/Sediment Control	1.00	LS	$50,000.00	$50,000	
Clear and Grub Access	5.00	ACRE	$8,000.00	$4[illegible]00	
Subtotal					210,000
West Stream					
Diversion					
Access Grading	12,000.00	SY	$2.00	$24,000	
Access Reinforcement	3,600.00	LF	$60.00	$216,000	
Diversion Excavation	2,700.00	CY	$10.00	$27,000	
Cofferdams	6.00	EA	$500.00	$3,000	
Subtotal					$270,000
Sediment Removal (3)					
Cement Solidification	650.00	CY	$25.00	$16,250	
Solidified Sediment Removal	1,300.00	CY	$50.00	$65,000	
Solidified Sediment Hauling	1,300.00	CY	$10.00	$13,000	
Comfirmational Sampling	80.00	EA	$100.00	$8,000	
Subtotal					$102,250
Restoration					
Stream FL Replacment Soil	650.00	CY	$15.00	$9,750	
Backfill Stream Flowline	650.00	CY	$5.00	$3,250	
Backfill Diversion	2,700.00	CY	$5.00	$13,500	
Vegetation	3.00	ACRE	$15,000.00	$45,000	
Subtotal					$72,000
West Stream Total					$444,000
East Stream					
Diversion					
Access Grading	9,000.00	SY	$2.00	$18,000	
Access Reinforcement	1,500.00	LF	$60.00	$90,000	
Diversion Excavation	1,200.00	CY	$10.00	$12,000	
Cofferdams	6.00	EA	$500.00	$3,000	
Subtotal					$123,000
Sediment Removal (3)					
Cement Solidification	250.00	CY	$25.00	$6,250	
Solidified Sediment Removal	500.00	CY	$50.00	$25,000	
Solidified Sediment Hauling	500.00	CY	$10.00	$5,000	
Comfirmational Sampling	40.00	EA	$100.00	$4,000	
Subtotal					$40,250
Restoration					
Stream FL Replacment Soil	250.00	CY	$15.00	$3,750	
Backfill Stream Flowline	250.00	CY	$5.00	$1,250	
Backfill Diversion	1,200.00	CY	$5.00	$6,000	
Vegetation	2.00	ACRE	$15,000.00	$30,000	
Subtotal					$41,000
East Stream Subtotal					$204,000
TOTAL DIRECT CAPITAL COSTS					$858,000
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$215,000	
Engineering (15% +/-)				$129,000	
Administration (5% +/-)				$43,000	
TOTAL INDIRECT CAPITAL COSTS					[illegible]387,000
TOTAL ESTIMATED REMEDIAL COST					[illegible]45,000

Notes:
1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget cost only.
3. Cost for sediment disposal is included in the soil remediation estimates.
4. Land aquistion costs not included.
5. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

NL I 002 0806

Table 28A
NL Industries, Inc. Site
South of U.S. Route 130
Sediment Alternative B (500 ppm) - Cost Estimate (1,5)
TEMPORARY STREAM DIVERSION

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation (4)					
Mobilization/Site Prep.	1.00	LS	$100,000.00	$100,000	
Health and Safety Plan	1.00	LS	$20,000.00	$20,000	
Erosion/Sediment Control	1.00	LS	$50,000.00	$50,000	
Clear and Grub Access	5.00	ACRE	$8,000.00	$40,000	
Subtotal					$210,000
West Stream					
Diversion					
Access Grading	12,000.00	SY	$2.00	$24,000	
Access Reinforcement	3,600.00	LF	$60.00	$216,000	
Diversion Excavation	2,700.00	CY	$10.00	$27,000	
Cofferdams	6.00	EA	$500.00	$3,000	
Subtotal					$270,000
Sediment Removal (3)					
Cement Solidification	1,100.00	CY	$25.00	$27,500	
Solidified Sediment Removal	2,200.00	CY	$50.00	$110,000	
Solidified Sediment Hauling	2,200.00	CY	$10.00	$22,000	
Comfirmational Sampling	80.00	EA	$100.00	$8,000	
Subtotal					$167,500
Restoration					
Stream FL Replacment Soil	1,100.00	CY	$15.00	$16,500	
Backfill Stream Flowline	1,100.00	CY	$5.00	$5,500	
Backfill Diversion	2,700.00	CY	$5.00	$13,500	
Vegetation	3.00	ACRE	$15,000.00	$45,000	
Subtotal					$81,000
West Stream Total					$519,000
East Stream					
Diversion					
Access Grading	9,000.00	SY	$2.00	$18,000	
Access Reinforcement	1,500.00	LF	$60.00	$90,000	
Diversion Excavation	1,200.00	CY	$10.00	$12,000	
Cofferdams	6.00	EA	$500.00	$3,000	
Subtotal					$123,000
Sediment Removal (3)					
Cement Solidification	400.00	CY	$25.00	$10,000	
Solidified Sediment Removal	800.00	CY	$50.00	$40,000	
Solidified Sediment Hauling	800.00	CY	$10.00	$8,000	
Comfirmational Sampling	40.00	EA	$100.00	$4,000	
Subtotal					$62,000
Restoration					
Stream FL Replacment Soil	400.00	CY	$15.00	$6,000	
Backfill Stream Flowline	400.00	CY	$5.00	$2,000	
Backfill Diversion	1,200.00	CY	$5.00	$6,000	
Vegetation	2.00	ACRE	$15,000.00	$30,000	
Subtotal					$44,000
East Stream Subtotal					$229,000
TOTAL DIRECT CAPITAL COSTS					$958,000
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$240,000	
Engineering (15% +/-)				$144,000	
Administration (5% +/-)				$48,000	
TOTAL INDIRECT CAPITAL COSTS					$432,000
TOTAL ESTIMATED REMEDIAL COST					$1,390,000

Notes:
1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget cost only.
3. Cost for sediment disposal is included in the soil remediation estimates.
4. Land aquistion costs not included.
5. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

Table 29
NL Industries, Inc. Site
South of U.S. Route 130
Sediment Alternative C (1,000 ppm) - Cost Estimate (1,5)
PERMANENT STREAM DIVERSION

5/12/93

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation (4)					
Mobilization/Site Prep.	1.00	LS	$100,000.00	$100,000	
Health and Safety Plan	1.00	LS	$20,000.00	$20,000	
Erosion/Sediment Control	1.00	LS	$50,000.00	$50,000	
Clear and Grub Access	5.00	ACRE	$8,000.00	$40,000	
Subtotal					$210,000
West Stream					
Diversion					
Access Grading	12,000.00	SY	$2.00	$24,000	
Access Reinforcement	3,600.00	LF	$60.00	$216,000	
Diversion Excavation	2,700.00	CY	$10.00	$27,000	
Diversion Fine Grading	4,000.00	SY	$3.00	$12,000	
Cofferdams	6.00	EA	$1,000.00	$6,000	
Subtotal					$285,000
Sediment Removal (3)					
Cement Solidification	650.00	CY	$25.00	$16,250	
Solidified Sediment Removal	1,300.00	CY	$50.00	$65,000	
Solidified Sediment Hauling	1,300.00	CY	$10.00	$13,000	
Comfirmational Sampling	80.00	EA	$100.00	$8,000	
Subtotal					$102,250
Restoration					
Stream FL Replacment Soil	650.00	CY	$15.00	$9,750	
Backfill Stream	650.00	CY	$7.00	$4,550	
Vegetation	3.00	ACRE	$15,000.00	$45,000	
Subtotal					$59,000
West Stream Total					$446,000
East Stream					
Diversion					
Access Grading	9,000.00	SY	$2.00	$18,000	
Access Reinforcement	1,500.00	LF	$60.00	$90,000	
Diversion Excavation	1,200.00	CY	$10.00	$12,000	
Diversion Fine Grading	1,700.00	SY	$3.00	$5,100	
Cofferdams	6.00	EA	$1,000.00	$6,000	
Subtotal					$131,100
Sediment Removal (3)					
Cement Solidification	250.00	CY	$25.00	$6,250	
Solidified Sediment Removal	500.00	CY	$50.00	$25,000	
Solidified Sediment Hauling	500.00	CY	$10.00	$5,000	
Comfirmational Sampling	40.00	EA	$100.00	$4,000	
Subtotal					$40,250
Restoration					
Stream FL Replacment Soil	250.00	CY	$15.00	$3,750	
Backfill Stream	250.00	CY	$7.00	$1,750	
Vegetation	2.00	ACRE	$15,000.00	$30,000	
Subtotal					$36,000
East Stream Total					$207,000
TOTAL DIRECT CAPITAL COSTS					$863,000
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$216,000	
Engineering (15% +/-)				$129,000	
Administration (5% +/-)				$43,000	
TOTAL INDIRECT CAPITAL COSTS					$388,000
TOTAL ESTIMATED REMEDIAL COST					$1,251,000

Notes:
1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget cost only.
3. Cost for sediment disposal is included in the soil remediation estimates.
4. Land aquistion costs not included.
5. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

NLI 002 0808

5/12/93

Table 29A
NL Industries, Inc. Site
South of U.S. Route 130
Sediment Alternative C (500 ppm) - Cost Estimate (1,5)
PERMANENT STREAM DIVERSION

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation (4)					
Mobilization/Site Prep.	1.00	LS	$100,000.00	$100,000	
Health and Safety Plan	1.00	LS	$20,000.00	$20,000	
Erosion/Sediment Control	1.00	LS	$50,000.00	$50,000	
Clear and Grub Access	5.00	ACRE	$8,000.00	$40,000	
Subtotal					$210,000
West Stream					
Diversion					
Access Grading	12,000.00	SY	$2.00	$24,000	
Access Reinforcement	3,600.00	LF	$60.00	$216,000	
Diversion Excavation	2,700.00	CY	$10.00	$27,000	
Diversion Fine Grading	4,000.00	SY	$3.00	$12,000	
Cofferdams	6.00	EA	$1,000.00	$6,000	
Subtotal					$285,000
Sediment Removal (3)					
Cement Solidification	1,100.00	CY	$25.00	$27,500	
Solidified Sediment Removal	2,200.00	CY	$50.00	$110,000	
Solidified Sediment Hauling	2,200.00	CY	$10.00	$22,000	
Comfirmational Sampling	80.00	EA	$100.00	$8,000	
Subtotal					$167,500
Restoration					
Stream FL Replacment Soil	1,100.00	CY	$15.00	$16,500	
Backfill Stream	1,100.00	CY	$7.00	$7,700	
Vegetation	3.00	ACRE	$15,000.00	$45,000	
Subtotal					$69,000
West Stream Total					$522,000
East Stream					
Diversion					
Access Grading	9,000.00	SY	$2.00	$18,000	
Access Reinforcement	1,500.00	LF	$60.00	$90,000	
Diversion Excavation	1,200.00	CY	$10.00	$12,000	
Diversion Fine Grading	1,700.00	SY	$3.00	$5,100	
Cofferdams	6.00	EA	$1,000.00	$6,000	
Subtotal					$131,100
Sediment Removal (3)					
Cement Solidification	400.00	CY	$25.00	$10,000	
Solidified Sediment Removal	800.00	CY	$50.00	$40,000	
Solidified Sediment Hauling	800.00	CY	$10.00	$8,000	
Comfirmational Sampling	40.00	EA	$100.00	$4,000	
Subtotal					$62,000
Restoration					
Stream FL Replacment Soil	400.00	CY	$15.00	$6,000	
Backfill Stream	400.00	CY	$7.00	$2,800	
Vegetation	2.00	ACRE	$15,000.00	$30,000	
Subtotal					$39,000
East Stream Total					$232,000
TOTAL DIRECT CAPITAL COSTS					**$964,000**
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$241,000	
Engineering (15% +/-)				$145,000	
Administration (5% +/-)				$48,000	
TOTAL INDIRECT CAPITAL COSTS					**$434,000**
TOTAL ESTIMATED REMEDIAL COST					**$1,398,000**

Notes:
1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget cost only.
3. Cost for sediment disposal is included in the soil remediation estimates.
4. Land aquistion costs not included.
5. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

NL I 002 0809

Table 30

NL Industries, Inc. Site
North of U.S. Route 130
Sediment Alternative B (1000 ppm) - Cost Estimate (1,5)
MECHANICAL DREDGING

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation (4)					
Mobilization/Site Prep.	1.00	LS	$100,000.00	$100,000	
Health and Safety Plan	1.00	LS	$20,000.00	$20,000	
Erosion/Sediment Control	1.00	LS	$50,000.00	$50,000	
Clear and Grub Access	5.00	ACRE	$8,000.00	$40,000	
Subtotal					$210,000
Mechanical Dredging	3,750.00	CY	$80.00	$300,000	
Subtotal					$300,000
Restoration					
Stream FL Replacment Soil	1,500.00	CY	$15.00	$22,500	
Backfill Stream Flowline	1,500.00	CY	$5.00	$7,500	
Vegetation	3.00	ACRE	$15,000.00	$45,000	
Subtotal					$75,000
Dredged Soil Disposal					
Loading	3,750.00	CY	$15.00	$56,250	
Haul Offsite Non-Hazardous Waste	3,000.00	CY	$20.00	$60,000	
Haul Offsite Hazardous Waste	750.00	CY	$50.00	$37,500	
Dispose Offsite Hazardous Waste	3,000.00	CY	$285.00	$855,000	
Dispose Offsite Non-Hazardous Waste	750.00	CY	$75.00	$56,250	
Subtotal					$1,065,000
TOTAL DIRECT CAPITAL COSTS					$1,350,000
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$338,000	
Engineering (15% +/-)				$203,000	
Administration (5% +/-)				$68,000	
TOTAL INDIRECT CAPITAL COSTS					$609,000
TOTAL ESTIMATED REMEDIAL COST					$1,959,000

Notes:
1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget cost only.
3. Cost for sediment disposal is included in the soil remediation estimates.
4. Land aquistion costs not included.
5. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

6/22/93

Table 30A
NL Industries, Inc. Site
North of U.S. Route 130
Sediment Alternative A - Cost Estimate (1,3)
NO ACTION

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
ANNUAL OPERATING AND MAINTENANCE COSTS					
Surface Water Monitoring Program					
Mobilization	1.00	LS	$500	$500	
Sampling Equipment	1.00	LS	$150	$150	
Sampler	12.00	Manhours	$50	$600	
Shipping	1.00	EA	$70	$70	
Analysis	5.00	Samples	$100	$500	
Analysis (QA/QC)	1.00	Samples	$100	$100	
Report	60.00	Manhours	$60	$3,600	
Subtotal (Semi-Annual Cost)				$5,520	
Annual Cost					$11,040
TOTAL ANNUAL O&M					**$11,040**
PRESENT WORTH (30 YR @ 5%)					**$170,000**
TOTAL ESTIMATED REMEDIAL COST					**$170,000**

Notes:
1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget estimate only.
3. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

NL Industries, Inc. Site
North of U.S. Route 130
Sediment Alternative B (500 ppm) - Cost Estimate (1,5)
MECHANICAL DREDGING

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Site Preparation (4)					
Mobilization/Site Prep.	1.00	LS	$100,000.00	$100,000	
Health and Safety Plan	1.00	LS	$20,000.00	$20,000	
Erosion/Sediment Control	1.00	LS	$50,000.00	$50,000	
Clear and Grub Access	5.00	ACRE	$8,000.00	$40,000	
Subtotal					$210,000
Mechanical Dredging	7,500.00	CY	$80.00	$600,000	
Subtotal					$600,000
Restoration					
Stream FL Replacment Soil	1,500.00	CY	$15.00	$22,500	
Backfill Stream Flowline	1,500.00	CY	$5.00	$7,500	
Vegetation	3.00	ACRE	$15,000.00	$45,000	
Subtotal					$75,000
Dredged Soil Disposal					
Loading	7,500.00	CY	$15.00	$112,500	
Haul Offsite Non-Hazardous Waste	6,000.00	CY	$20.00	$120,000	
Haul Offsite Hazardous Waste	1,500.00	CY	$50.00	$75,000	
Dispose Offsite Hazardous Waste	6,000.00	CY	$285.00	$1,710,000	
Dispose Offsite Non-Hazardous Waste	1,500.00	CY	$75.00	$112,500	
Subtotal					$2,130,000
TOTAL DIRECT CAPITAL COSTS					$2,415,000
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$604,000	
Engineering (15% +/-)				$362,000	
Administration (5% +/-)				$121,000	
TOTAL INDIRECT CAPITAL COSTS					$1,087,000
TOTAL ESTIMATED REMEDIAL COST					$3,502,000

Notes:
1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget cost only.
3. Cost for sediment disposal is included in the soil remediation estimates.
4. Land aquistion costs not included.
5. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

TABLE 32

NL Industries, Inc. Site
Miscellaneous Components - Cost Estimate (1,3)

Item (2)	Quantity	Units	Unit Cost	Extended Cost	Total Cost
DIRECT CAPITAL COSTS					
Shower Tank					
Excavation	75.00	CY	$15.00	$1,125	
Soil Management	75.00	CY	$20.00	$1,500	
Tank Removal / Cleaning	1.00	LS	$1,000.00	$1,000	
Tank Disposal	2.50	Tons	$100.00	$250	
Confirmational Sampling	4.00	Samples	$25.00	$100	
Fill	110.00	CY	$15.00	$1,650	
Subtotal					$5,625
Septic Tank / Leach Mound					
Pump Septic Tank	1.00	LS	$1,000.00	$1,000	
Fill	330.00	CY	$15.00	$4,950	
Remove and Dispose Piping	1.00	LS	$10,000.00	$10,000	
Final Grading	4,500.00	SY	$2.00	$9,000	
Subtotal					$24,950
TOTAL DIRECT CAPITAL COSTS					$30,575
INDIRECT CAPITAL COSTS					
Contingency (25% +/-)				$8,000	
Engineering (15% +/-)				$5,000	
Administration (5% +/-)				$2,000	
TOTAL INDIRECT CAPITAL COSTS					$15,000
TOTAL ESTIMATED REMEDIAL COST					$46,000

Notes:
1. Cost estimate based on R.S. Means 1990 Construction Cost Data, and O'Brien & Gere Engineers, Inc. professional experience.
2. Line items provided to form budget estimate only.
3. The costs in this table were developed based upon the data currently available and several assumptions necessary to evaluate the alternatives. Because of the incomplete nature of this data and the possibility that actual conditions may vary considerably from these base assumptions, these costs are not necessarily indicative of the actual remediation costs that will be incurred. These costs should only be used for comparison of technical alternatives.

Table 33
NL Industries, Inc. Site
SOIL REMEDIAL ALTERNATIVE SUMMARY

	ALTERNATIVE A	ALTERNATIVE B	ALTERNATIVE C	ALTERNATIVE D
Key Components	Fencing Deed restrictions	Bench scale tests, Field demonstrations of technology on-site, Excavation Soil Washing of excavated soil, Replacement of washed soil on-site S/S of hazardous washed soil with off-site disposal	Excavation, off-site solidification/ stabilization (S/S) of all soil with off-site disposal.	Bench scale tests, Field demonstrations of technology on-site, Excavation Soil washing of hazardous non-land disposable soils, Consolidation area on-site, offsite disposal of hazardous land disposable soils.
Overall Protection of human health and the environment				
-How risks are eliminated, reduced, or controlled	Fencing and institutional controls limit risk of direct human contact with contaminated soils.	Excavation, soil washing, remove lead from soil, limits direct human & biota contact with soil. Solidified soil is removed from site.	Excavation, S/S and off-site disposal removes soil.	Excavation, soil washing removes lead from soil, soil consolidation limits direct human & biota contact with soil. Offsite disposal limits direct contact with contaminated soil.
Compliance with ARARs				
-Compliance with ARARs	ARARs will not be met.	ARARs will be met.	ARARs will be met.	ARARs will be met.
Long Term Effectiveness				
- Magnitude of residual risk	Risk of human exposure minimized but not eliminated. biota exposure not eliminated.	Contaminated soil contained to prevent human and biota contact.	Contaminated soil removed to prevent human and biota contact.	Contaminated soil removed or contained to prevent human and biota contact.
- Adequacy of controls	Marginal	Soil washing is effective on sands but not silts or clay.	S/S is effective in immobilizing inorganic contaminants in soil.	Dependant on landfill selected. Consolidation area is durable and effective.
-Reliability of controls	Fencing will require repair and maintenance.	None required	Dependent on landfill selected	Consolidation area will require maintenance. Dependant on landfill selected.
Reduction of Toxicity, Mobility, or Volume	No reduction of toxicity, mobility, or volume through treatment.	Remaining soil would meet response objectives.	Remaining soil would meet response objectives.	Remaining soil would meet response objectives.
Short Term Effectiveness				
- Time until protection is achieved **	3 months	2½ - 3½ years	1½ - 2 years	2½ - 3 years
- Protection of community during remedial actions	Minimal short term impact.	Dust and noise monitoring and control required.	Dust and noise monitoring and control required.	Dust and noise monitoring and control required.
- Protection of workers during remedial actions	Minimal short term impact.	Dust and noise monitoring and control required.	Dust and noise monitoring and control required.	Dust and noise monitoring and control required.
- Protection of environment during remedial actions	Minimal short term impact.	Wetlands impacts will occur. Silt and sedimentation controls required.	Wetlands impacts will occur. Silt and sedimentation controls required.	Wetlands impacts will occur. Silt and sedimentation controls required.
Implementability				
- Technical feasibility	Standard construction techniques.	Materials handling problems are prevalent in soil washing. Field studies on lead battery-recycling site indicate soil washing is not effective in removing lead from soil.	Standard construction techniques.	Standard construction techniques.
- Administrative feasibility	No administrative difficulties anticipated.	Significant input from State and local authorities expected.	Significant input from State and local authorities expected.	Coordination with government agencies required.
- Availability of services and materials	Services and materials locally available.	Services and materials locally available.	Services and materials locally available.	Services and materials locally available.

Cost	A: 1,000 ppm response	A: 500 ppm response	B: 1,000 ppm response	B: 500 ppm response	C: 1,000 ppm response	C: 500 ppm response	D: 1,000 ppm response	D: 500 ppm response
- Capital Cost	$149,000		$13,431,000	$19,408,000	$7,367,000	$10,339,000	$8,790,000	$10,383,300
- Annual O&M	$2,000		$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
- Present Worth (i=5%, 30 yrs)	$30,400		$77,000	$77,000	$77,000	$77,000	$77,000	$77,000
Total Estimated Remedial Cost	$179,400		$13,508,000	$19,485,000	$7,444,000	$10,416,000	$8,867,000	$10,460,300

Table 33 (Continued)
NL Industries, Inc.
SOIL REMEDIAL ALTERNATIVES SUMMARY

	ALTERNATIVE E	ALTERNATIVE F	ALTERNATIVE G	ALTERNATIVE H
Key Components	**Excavation, on-site S/S of hazardous soil requiring treatment followed by offsite disposal, offsite disposal of hazardous land disposable soils, on-site consolidation of non-hazardous soil.**	**Excavation, on-site S/S of all hazardous soil, on-site consolidation of treated soil and non-hazardous soil.**	**Excavation of soil; Disposal at off-site landfill.**	**Excavation of on-site soil over 1,000 ppm Lead and offsite and wetland soils over 500 ppm Lead. Treatment of hazardous soils requiring treatment, disposal of hazardous land disposable soils, on-site consolidation of non-hazardous soils, on-site backfill of offsite soils less than 1,000 ppm.**
Overall Protection of human health and the environment				
-How risks are eliminated, reduced, or controlled	Excavation, S/S, soil consolidation and offstie disposal limits direct human and biota contact with soil.	Excavation, S/S and soil consolidation limits direct human & biota contact with soil.	Excavation and off-site disposal eliminates direct contact (human and biota) with contaminated soil.	Excavation, treatment and soil consolidation eliminates direct contact (human and biota) with contaminated soil.
Compliance with ARARs				
-Compliance with ARARs	ARARs will be met.	ARARs will be met.	ARARs will be met.	ARARs will be met.
Long Term Effectiveness				
- Magnitude of residual risk	Contaminated soil contained to prevent human and biota contact.	Contaminated soil contained to prevent human and biota contact.	Contaminated soil removed to prevent human and biota contact.	Contaminated soil removed to prevent human and biota contact.
- Adequacy of controls	S/S is effective in immobilizing inorganic contaminants in soil. Consolidation area is durable and effective.	S/S is effective in immobilizing inorganic contaminants in soil. Consolidation area is durable and effective.	Largely dependent on landfill selected.	Dependent on landfill selected. Consolidation area is durable and effective.
-Reliability of controls	Consolidation area will require maintenance.	Consolidation area will require maintenance.	Dependent on landfill selected.	Dependent on landfill selected. Consolidation area will require maintenance.
Reduction of Toxicity, Mobility, or Volume	Remaining soil would meet response objectives.	Remaining soil would meet response objectives.	No reduction of toxicity, mobility, or volume through treatment.	Remaining soil would meet response objectives.
Short Term Effectiveness				
- Time until protection is achieved **	1½ - 2 years	1½ - 2 years	1½ - 2 years	2 - 3½ years
- Protection of community during remedial actions	Dust and noise monitoring and control required.	Dust and noise monitoring and control required.	Dust and noise monitoring and control required. Significant off-site transport of excavated soil involved.	Dust and noise monitoring and control required. Significant off-site transport of excavated soil involved.
- Protection of workers during remedial actions	Dust and noise monitoring and control required.	Dust and noise monitoring and control required.	Dust and noise monitoring and control required.	Dust and noise monitoring and control required.
- Protection of environment during remedial actions	Wetlands impacts will occur. Silt and sedimentation controls required.	Wetlands impacts will occur. Silt and sedimentation controls required.	Wetlands impacts will occur. Silt and sedimentation controls required.	Wetlands impacts will occur. Silt and sedimentation controls required.
Implementability				
- Technical feasibility	Standard construction techniques.	Standard construction techniques.	Standard construction techniques.	Standard construction techniques.
- Administrative feasibility	Significant input from State and local authorities expected.	Significant input from State and local authorities expected.	Coordination with government agencies required.	Coordination with government agencies required.
- Availability of services and materials	Services and materials locally available.	Services and materials locally available.	Services and materials locally available.	Services and materials locally available.

Cost	E: 1,000 ppm response	E: 500 ppm response	F: 1,000 ppm response	F: 500 ppm response	G: 1,000 ppm response	G: 500 ppm response	H: 1,000 ppm response	H: 500 ppm response
- Capital Cost	$8,228,000	$9,065,000	$5,111,000	$6,051,000	$6,418,000	$7,988,000		$9,564,000
- Annual O&M	$5,000	$5,000	$5,000	$5,000	N/A	N/A		$5,000
- Present Worth (I=5%, 30 yrs)	$77,000	$77,000	$77,000	$77,000	N/A	N/A		$77,000
Total Estimated Remedial Cost	$8,305,000	$9,142,000	$5,188,000	$6,128,000	$9,307,000	$11,582,000		$9,641,000

** Includes time for necessary agency approvals, permitting requirements, and negotiations; which was estimated based on similar programs and agency input.

Table 34

NL Industries, Inc. Site

GROUND WATER REMEDIAL ALTERNATIVE SUMMARY

6/22/93

Key Components	ALTERNATIVE A	ALTERNATIVE B	ALTERNATIVE C	ALTERNATIVE D
	Ground water monitoring program Biennial sampling of 10 on-site wells - analysis for total arsenic cadmium, lead, pH, conductivity sulfate, and TDS.	**Monitoring program of Alternative A Pump & Treat using existing well point system. On-site treatment by precipitation/flocculation followed by ion exchange. Discharge to ground water via infiltration pond.**	**Monitoring program of Alternative A Pump & Treat using existing well point system. On-site treatment by precipitation/flocculation followed by ion exchange. Discharge to ground water via leach field.**	**Monitoring program of Alternative A Pump & Treat using existing well point system. On-site treatment by precipitation/flocculation followed by ion exchange. Discharge to ground water via infiltration trenches.**
Overall Protection of human health and the environment				
- How risks are eliminated, reduced, or controlled	Monitoring	Ground water recovered and treated.	Ground water recovered and treated.	Ground water recovered and treated.
Compliance with ARARs				
- Compliance with ARARs	ARARs will not be met.	ARARs will be met.	ARARs will be met.	ARARs will be met.
Long Term Effectiveness				
- Magnitude of residual risk	Site ground water does not meet MCLs.	Risk of human exposure due to contaminant migration through ground water significantly reduced.	Risk of human exposure due to contaminant migration through ground water significantly reduced.	Risk of human exposure due to contaminant migration through ground water significantly reduced.
- Adequacy of controls	No controls at Site.	Bench-scale test required to determine effectiveness of treatment train.	Bench-scale test required to determine effectiveness of treatment train.	Bench-scale test required to determine effectiveness of treatment train.
- Reliability of controls	No controls at Site.	Water treatment plant reliable with proper operation and maintenance.	Water treatment plant reliable with proper operation and maintenance.	Water treatment plant reliable with proper operation and maintenance.
Reduction of Toxicity, Mobility, or Volume	No reduction of toxicity, mobility, or volume through treatment.	Toxicity of ground water reduced by treatment - sludge generated.	Toxicity of ground water reduced by treatment - sludge generated.	Toxicity of ground water reduced by treatment - sludge generated.
Short Term Effectiveness				
- Time until protection is achieved **	-	2½ - 3 years	2½ - 3 years	2½ - 3 years
- Protection of community during remedial actions	Minimal short term impact.	Minimal short term impact.	Minimal short term impact.	Minimal short term impact.
- Protection of workers during remedial actions	Minimal short term impact.	Minimal short term impact.	Minimal short term impact.	Minimal short term impact.
- Protection of environment during remedial actions	Minimal short term impact.	Silt and sediment controls required.	Silt and sediment controls required.	Silt and sediment controls required.
Implementability				
- Technical feasibility	Standard monitoring techniques.	Preliminary calculations indicate a 10-acre infiltration pond will be required, which is not readily available.	Preliminary calculations indicate a 30-acre leach field will be required, which is not readily available.	Preliminary calculations indicate an area of 20-acres is required, which is not readily available.
- Administrative feasibility	No administrative difficulties anticipated.	Coordination with government agencies and residents required.	Coordination with government agencies and residents required.	Coordination with government agencies and residents required.
- Availability of services and materials	Services and materials locally available.	Services and materials locally available.	Services and materials locally available.	Services and materials locally available.
Cost				
- Capital cost	$10,000	$2.802,000	$3,364.000	$2,894,000
- Annual O & M	$3,245	$402,025	$429.505	$405,705
- Present worth (I=5%, 30 yrs)	$50,000	$65,180,000	$6.602.000	$6,236.000
Total Estimated Remedial Cost	$60,000	$8,982,000	$9,966.000	$9.130.000

NLI 002 0817

Table 34 (Continued)
NL Industries, Inc. Site
GROUND WATER REMEDIAL ALTERNATIVE SUMMARY

6/22/93

	ALTERNATIVE E	ALTERNATIVE F	ALTERNATIVE G (Streams)	ALTERNATIVE G (Delaware)
Key Components	Monitoring program of Alternative A Pump & Treat using existing well point system. On-site treatment by precipitation/flocculation followed by ion exchange. Discharge to ground water via reinjection wells to unconfined aquifer.	Monitoring program of Alternative A Pump & Treat using existing well point system. On-site treatment by precipitation/flocculation followed by ion exchange and optional reverse osmosis for TDS control. Dicharge to ground water via reinjection wells to confined aquifer.	Monitoring program of Alternative A Pump & Treat using existing well point system. On-site treatment by precipitation/flocculation followed by ion exchange & reverse osmosis. Direct discharge to East Stream.	Monitoring program of Alternative A Pump & Treat using existing well point system. On-site treatment by precipitation/flocculation followed by ion exchange. Direct discharge to Delaware River.
Overall Protection of human health and the environment				
-How risks are eliminated, reduced, or controlled	Ground water recovered and treated.	Ground water recovered and treated.	Ground water recovered and treated.	Ground water recovered and treated.
Compliance with ARARs				
-Compliance with ARARs	ARARs will be met.	ARARs will be met.	ARARs will be met.	ARARs will be met.
Long Term Effectiveness				
- Magnitude of residual risk	Risk of human exposure due to contaminant migration through ground water significantly reduced.	Risk of human exposure due to contaminant migration through ground water significantly reduced.	Risk of human exposure due to contaminant migration through ground water significantly reduced.	Risk of human exposure due to contaminant migration through ground water significantly reduced.
- Adequacy of controls	Bench-scale test required to determine effectiveness of treatment train.	Bench-scale test required to determine effectiveness of treatment train.	Bench-scale test required to determine effectiveness of treatment train.	Bench-scale test required to determine effectiveness of treatment train.
-Reliability of controls	Water treatment plant reliable with proper operation and maintenance.	Water treatment plant reliable with proper operation and maintenance.	Water treatment plant reliable with proper operation and maintenance.	Water treatment plant reliable with proper operation and maintenance.
Reduction of Toxicity, Mobility, or Volume	Toxicity of ground water reduced by treatment - sludge generated.	Toxicity of ground water reduced by treatment - sludge generated.	Toxicity of ground water reduced by treatment - sludge generated.	Toxicity of ground water reduced by treatment - sludge generated.
Short Term Effectiveness				
- Time until protection is achieved **	2½ - 3 years	2 - 3 years	3 - 4 years	3½ - 4 years
- Protection of community during remedial actions	Minimal short term impact.	Minimal short term impact.	Minimal short term impact.	Minimal short term impact.
- Protection of workers during remedial actions	Minimal short term impact.	Minimal short term impact.	Minimal short term impact.	Minimal short term impact.
- Protection of environment during remedial actions	Silt and sediment controls required.	Silt and sediment controls required.	Silt and sediment controls required.	Silt and sediment controls required.
Implementability				
- Technical feasibility	The implementation of this alternative could result in a significant mounding effect, which could impact surface structures and the landfill area.	Standard construction and monitoring techniques.	Standard construction and monitoring techniques.	Standard construction and monitoring techniques.
- Administrative feasibility	Coordination with government agencies and residents required.	Coordination with government agencies and residents required.	Coordination with government agencies required.	Coordination with government agencies required.
- Availability of services and materials	Services and materials locally available.	Services and materials locally available.	Services and materials locally available.	Services and materials locally available.
Cost				
- Capital cost	$2,643,000	$2,532,000	$3,741,000	$3,525,000
- Annual O & M	$410,665	$391,225	$510,705	[illegible],245
- Present worth (I=5%, 30 yrs)	$6,313,000	$6,014,000	$7,851,000	$6,568,000
Total Estimated Remedial Cost	$8,956,000	$8,546,000	$11,592,000	$10,093,000

** Includes time for necessary agency approvals, permitting requirements, and negotiations; which was estimated ba [illegible] similar programs and agency input.

Table 3

NL Industries, Inc. Site

SEDIMENT REMEDIAL ALTERNATIVE SUMMARY

(South of U.S. Route 130)

Key Components	ALTERNATIVE A Semi-Annual sampling of surface water in West Stream	ALTERNATIVE B Temporary diversion of Streams, Remove sediments in Streams south of U.S. Rte. 130, sample, Divert water back into Streams, backfill diversions.	ALTERNATIVE C Permanent diversion of Streams Remove sediments in Streams south of U.S. Rte. 130. Backfill Streams.
Overall Protection of human health and the environment			
–How risks are eliminated, reduced, or controlled	No human risk, but sediments which exceed response objectives could impact biota and surface water quality.	Sediments which exceed response objectives would be removed.	Sediments which exceed response objectives would be removed.
Compliance with ARARs			
–Compliance with ARARs	ARARs will not be met.	ARARs will be met.	ARARs will be met.
Long Term Effectiveness			
– Magnitude of residual risk	Sediments which do not meet response objectives would be left in place.	No residual risk.	No residual risk.
– Adequacy of controls	No controls at Site.	Sediments which exceed response objectives would be removed.	Sediments which exceed response objectives would be removed.
–Reliability of controls	No controls at Site.	Sediments which exceed response objectives would be removed.	Sediments which exceed response objectives would be removed.
Reduction of Toxicity, Mobility, or Volume	No reduction of toxicity, mobility, or volume through treatment.	No reduction of toxicity, mobility, or volume through treatment.	No reduction of toxicity, mobility, or volume through treatment.
Short Term Effectiveness			
– Time until protection is achieved **	–	1½ – 2 years	1½ – 2 years
– Protection of community during remedial actions	No short term impact.	Minimal short term impact.	Minimal short term impact.
– Protection of workers during remedial actions	No short term impact.	Minimal short term impact.	Minimal short term impact.
– Protection of environment during remedial actions	No short term impact.	Silt and sediment controls required.	Silt and sediment controls required.
Implementability			
– Technical feasibility	Standard monitoring techniques.	Standard construction and monitoring techniques.	Standard construction and monitoring techniques.
– Administrative feasibility	No administrative difficulties anticipated.	Coordination with government agencies required.	Coordination with government agencies required.
– Availability of services and materials	Services and materials locally available.	Services and materials locally available.	Services and materials locally available.

Cost	Alt. A 1,000 ppm response	Alt. A 500 ppm response	Alt. B 1,000 ppm response	Alt. B 500 ppm response	Alt. C 1,000 ppm response	Alt. C 500 ppm response
– Capital cost	$0		$858,000	$958,000	$863,000	$964,000
– Annual O & M	$13,580		N/A	N/A	N/A	N/A
– Present worth (I=5%, 30 yrs)	$209,000		N/A	N/A	N/A	N/A
Total Estimated Remedial Cost	$209,000		$1,245,000	$1,390,000	$1,251,000	$1,398,000

Table 36

NL Industries, Inc. Site

SEDIMENT REMEDIAL ALTERNATIVE SUMMARY

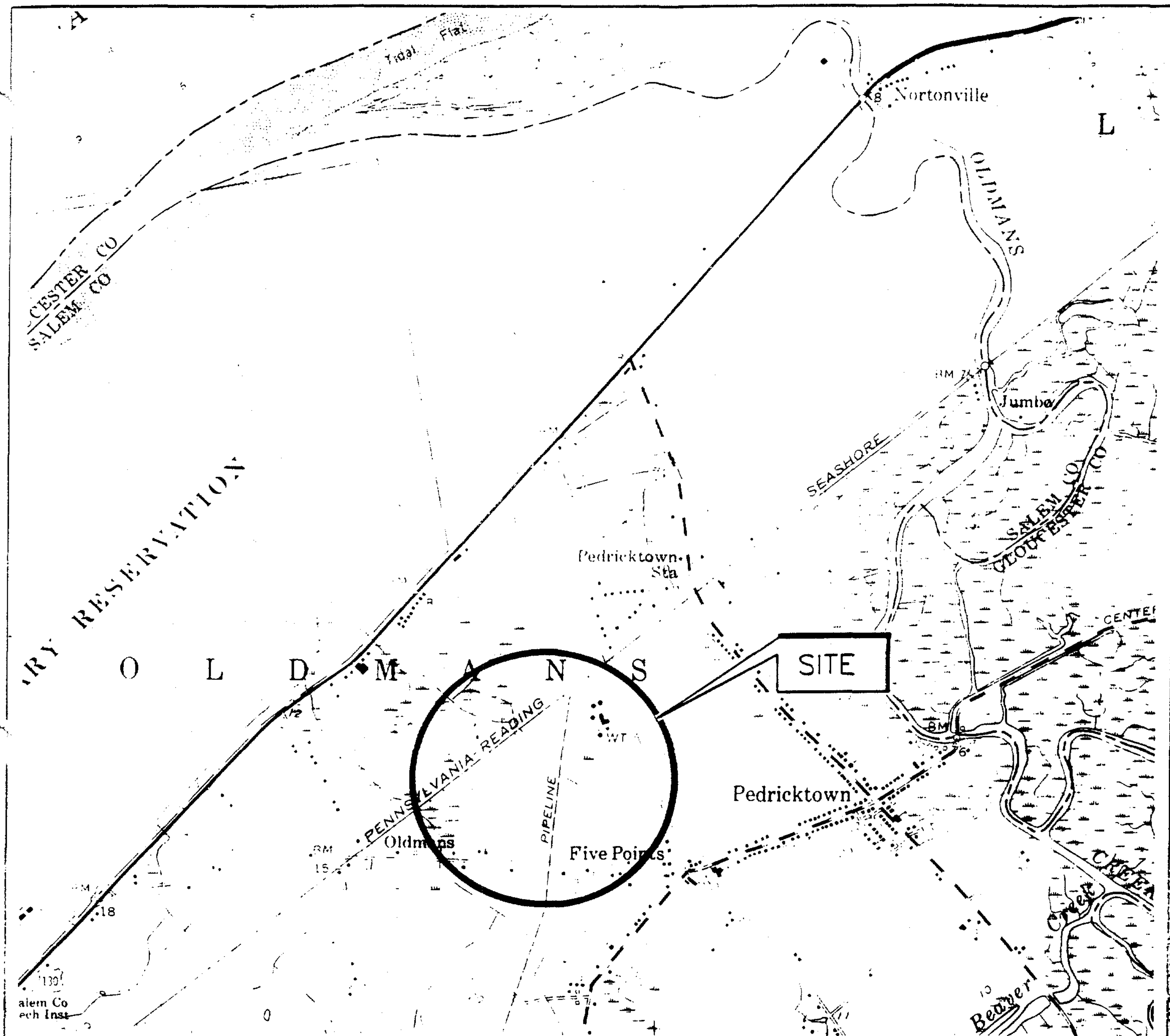
(North of U.S. Route 130)

	ALTERNATIVE A	ALTERNATIVE B	
Key Components	Semi-Annual sampling of surface water in streams North of U.S. Route 130.	Mechanical dredging of streams north of U.S. Route 130, treatment and/or disposal of dredged sediments, backfill streams.	
Overall Protection of human health and the environment			
–How risks are eliminated, reduced, or controlled	No human risk, but sediments which exceed response objectives could impact biota and surface water quality.	Sediments which exceed response objectives would be removed.	
Compliance with ARARs			
–Compliance with ARARs	ARARs will not be met.	ARARs will be met.	
Long Term Effectiveness			
– Magnitude of residual risk	Sediments which do not meet response objectives would be left in place.	No residual risk.	
– Adequacy of controls	No controls at Site.	Sediments which exceed response objectives would be removed.	
–Reliability of controls	No controls at Site.	Sediments which exceed response objectives would be removed.	
Reduction of Toxicity, Mobility, or Volume	No reduction of toxicity, mobility, or volume through treatment.	Dependant of treatment/disposal methods.	
Short Term Effectiveness			
– Time until protection is achieved **	–	1½ – 2 years	
– Protection of community during remedial actions	No short term impact.	Minimal short term impact.	
– Protection of workers during remedial actions	No short term impact.	Minimal short term impact.	
– Protection of environment during remedial actions	No short term impact	Impact to environment caused by excavation actvities. Significant silt and sediment controls required.	
Implementability			
– Technical feasibility	Standard monitoring techniques.	Standard construction and monitoring techniques.	
– Administrative feasibility	No administrative difficulties anticipated.	Coordination with government agencies required.	
– Availability of services and materials	**Services and materials locally available.**	**Services and materials locally available.**	
Cost		**1,000 ppm response**	**500 ppm response**
– Capital cost	**$0**	**$ 1 350,000**	**$2,415,000**
– Annual O & M	**$11,040**	**N/A**	**N/A**
– Present worth (I=5%, 30 yrs)	**$170,000**	**N/A**	**N/A**
Total Estimated Remedial Cost	**$170,000**	**$ 1,959,000**	**$3,502,000**

** Includes time for necessary agency approvals, permitting requirements and negotiations; which was estimated based on similar programs and agency input.

FIGURES

FIGURE 1



SITE LOCATION MAP

NL INDUSTRIES, INC. SITE
PEDRICKTOWN, N.J.

QUADRANGLE LOCATION

THIS MAP TAKEN FROM THE
MARCUS HOOK, PA.–N.J.–DEL
USGS QUADRANGLE

N=340,000
E=1,786,780

N

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

SCALE: 1:24000

ENGINEERS INC.
Edison, New Jersey

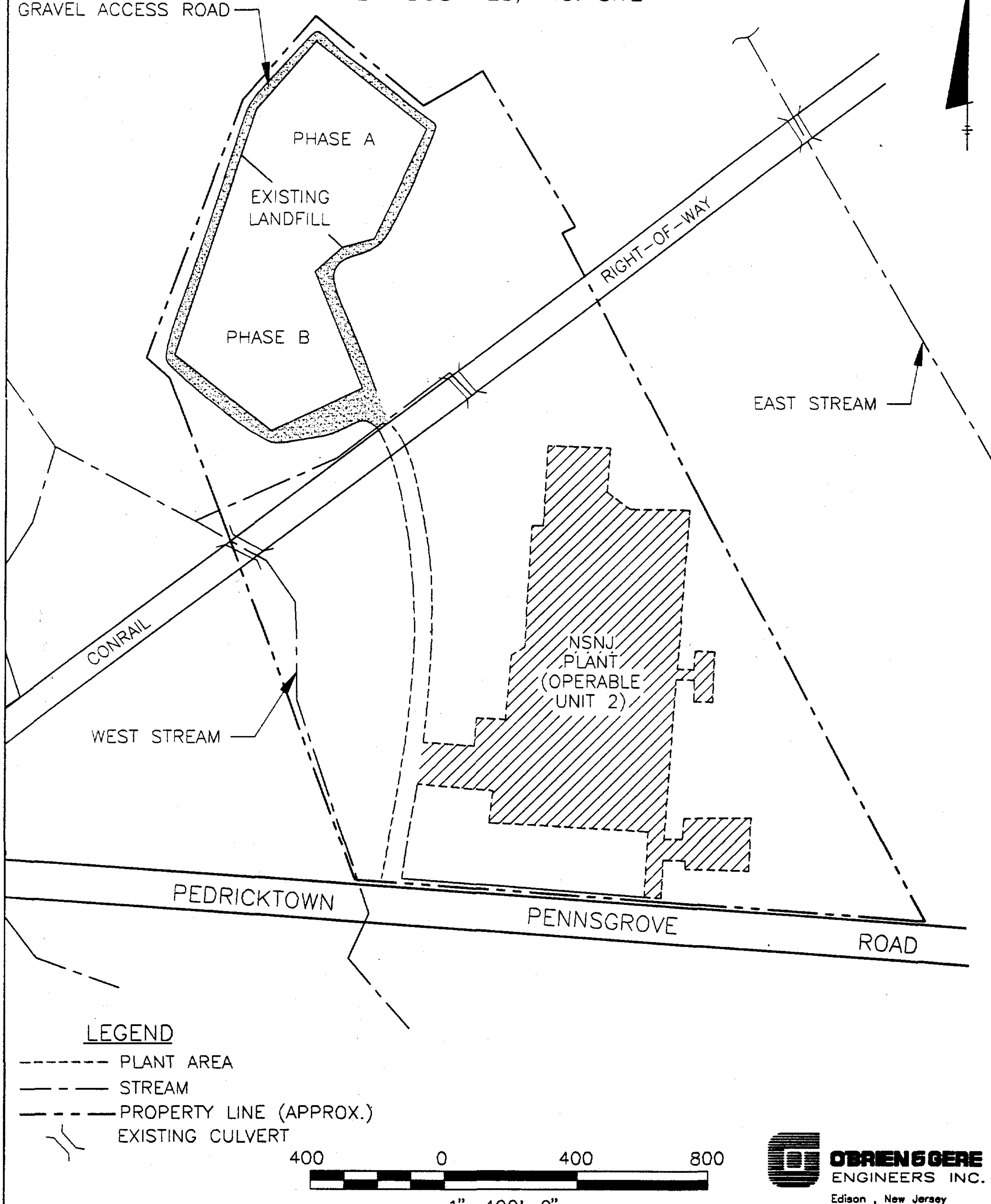
NLI 002 0821

0096-124482

SITE MAP

FIGURE 2

NL INDUSTRIES, INC. SITE



O'BRIEN & GERE ENGINEERS INC.
Edison, New Jersey

NLI 002 0822

EPA REGION II
SCANNING TRACKING SHEET

DOC ID # 54417

DOC TITLE/SUBJECT:
FIGURE 3
SOIL AND SEDIMENT SAMPLE
LOCATION MAP

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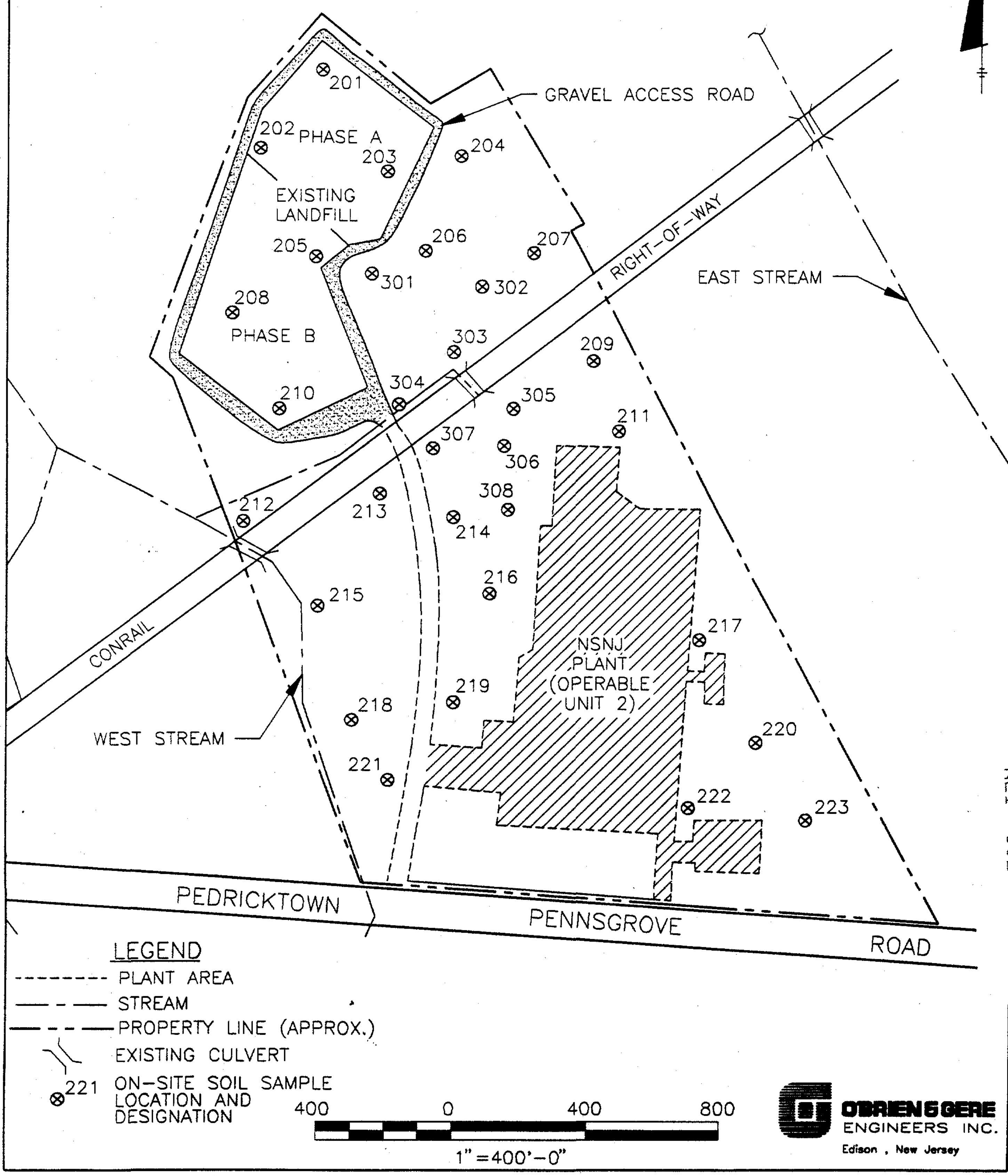
SUPERFUND RECORDS CENTER
290 BROADWAY, 18TH FLOOR
NEW YORK, NY 10007

FIGURE 4

SOIL SAMPLE LOCATIONS: ON-SITE

NL INDUSTRIES, INC. SITE

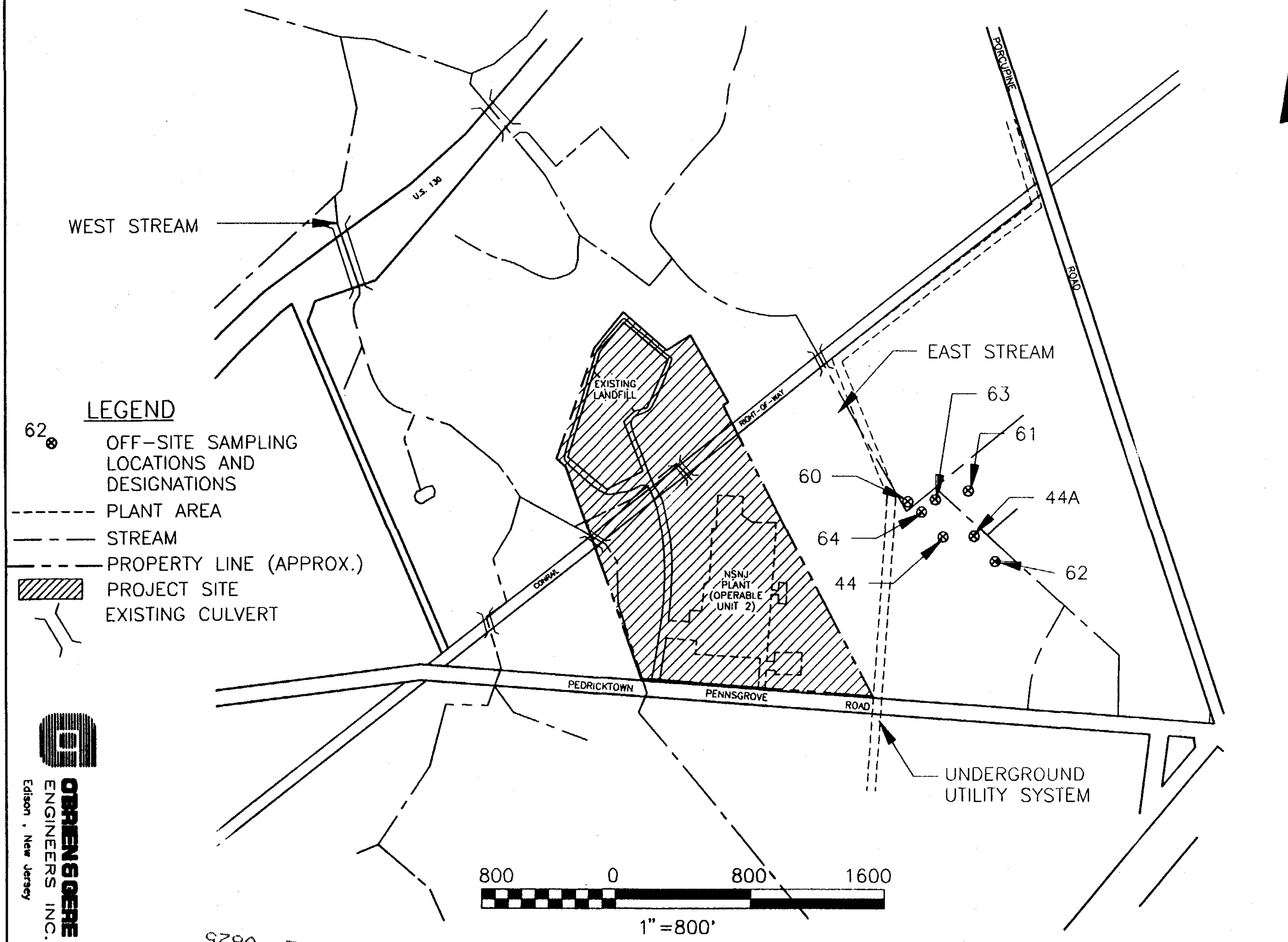


O'BRIEN & GERE ENGINEERS INC.
Edison , New Jersey

NLI 002 0824

SOIL SAMPLE LOCATIONS IN VICINITY OF EAST STREAM

NL INDUSTRIES, INC. SITE



284442-9600

FIGURE 5

NLI 002 0825

284433-9600

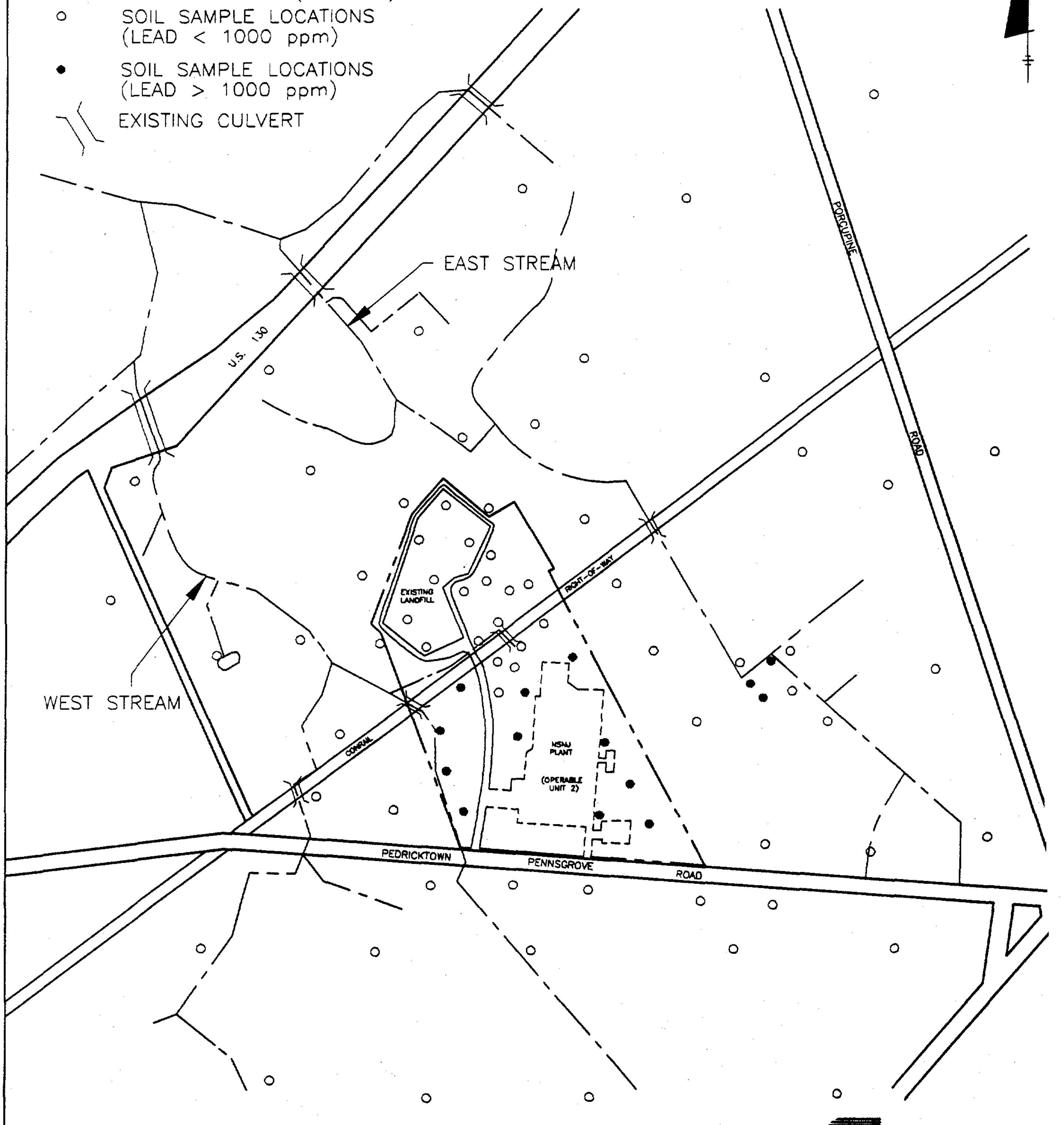
SOIL SAMPLE LOCATIONS
1000 ppm LEAD CRITERIA(1)

NL INDUSTRIES, INC. SITE

FIGURE 6

LEGEND

- PLANT AREA
- STREAM
- PROPERTY LINE (APPROX.)
- SOIL SAMPLE LOCATIONS (LEAD < 1000 ppm)
- SOIL SAMPLE LOCATIONS (LEAD > 1000 ppm)
- EXISTING CULVERT



(1) BASED ON MAXIMUM OBSERVED CONCENTRATION AT SOIL SAMPLE LOCATION.

800 0 800 1600

1" =800'

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284432-9600

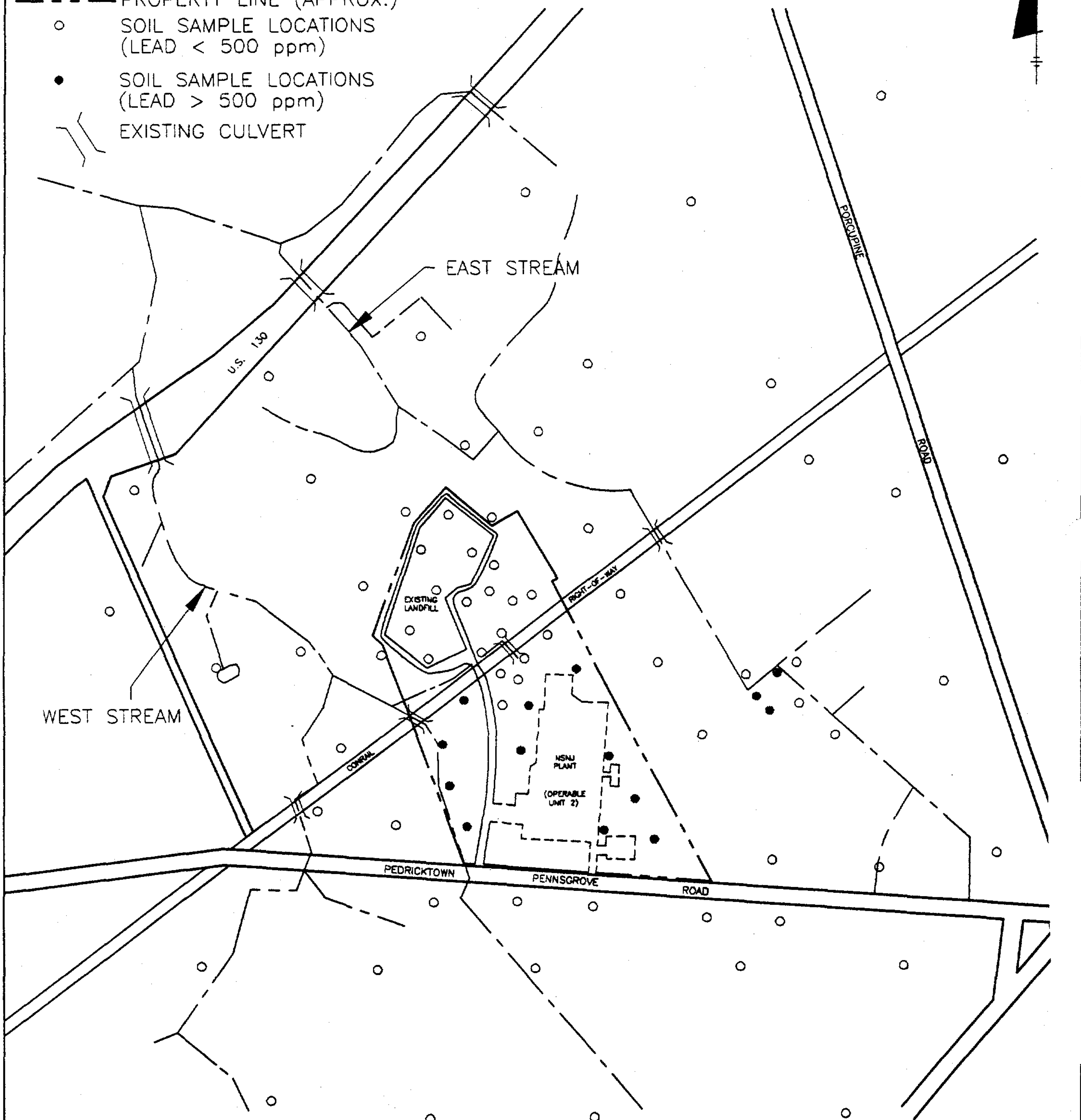
SOIL SAMPLE LOCATIONS
500 ppm LEAD CRITERIA(1)

FIGURE 7

NL INDUSTRIES, INC. SITE

LEGEND

- - - - - - - PLANT AREA
— - - — STREAM
—— - - —— PROPERTY LINE (APPROX.)
○ SOIL SAMPLE LOCATIONS (LEAD < 500 ppm)
● SOIL SAMPLE LOCATIONS (LEAD > 500 ppm)
EXISTING CULVERT



800 0 800 1600

1" =800'

(1) BASED ON MAXIMUM OBSERVED CONCENTRATION AT SOIL SAMPLE LOCATION.

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284431-9600

ASSESSMENT AREAS FOR WETLAND EVALUATION TECHNIQUE

FIGURE 7.1

NL INDUSTRIES, INC. SITE

LEGEND

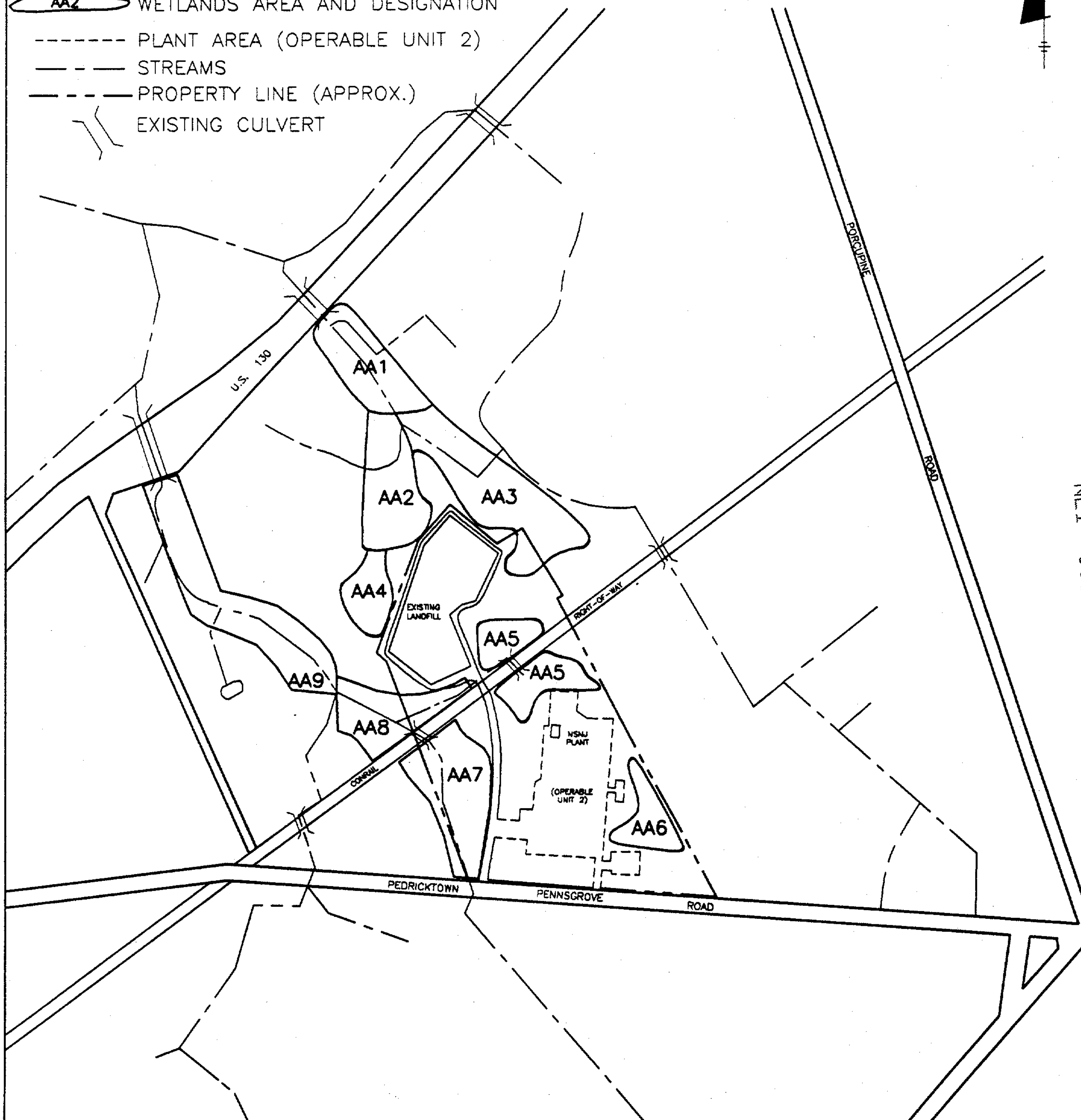
AA2 WETLANDS AREA AND DESIGNATION

PLANT AREA (OPERABLE UNIT 2)

STREAMS

PROPERTY LINE (APPROX.)

EXISTING CULVERT



800 0 800 1600

1"=800'

O'BRIEN & GERE ENGINEERS INC.

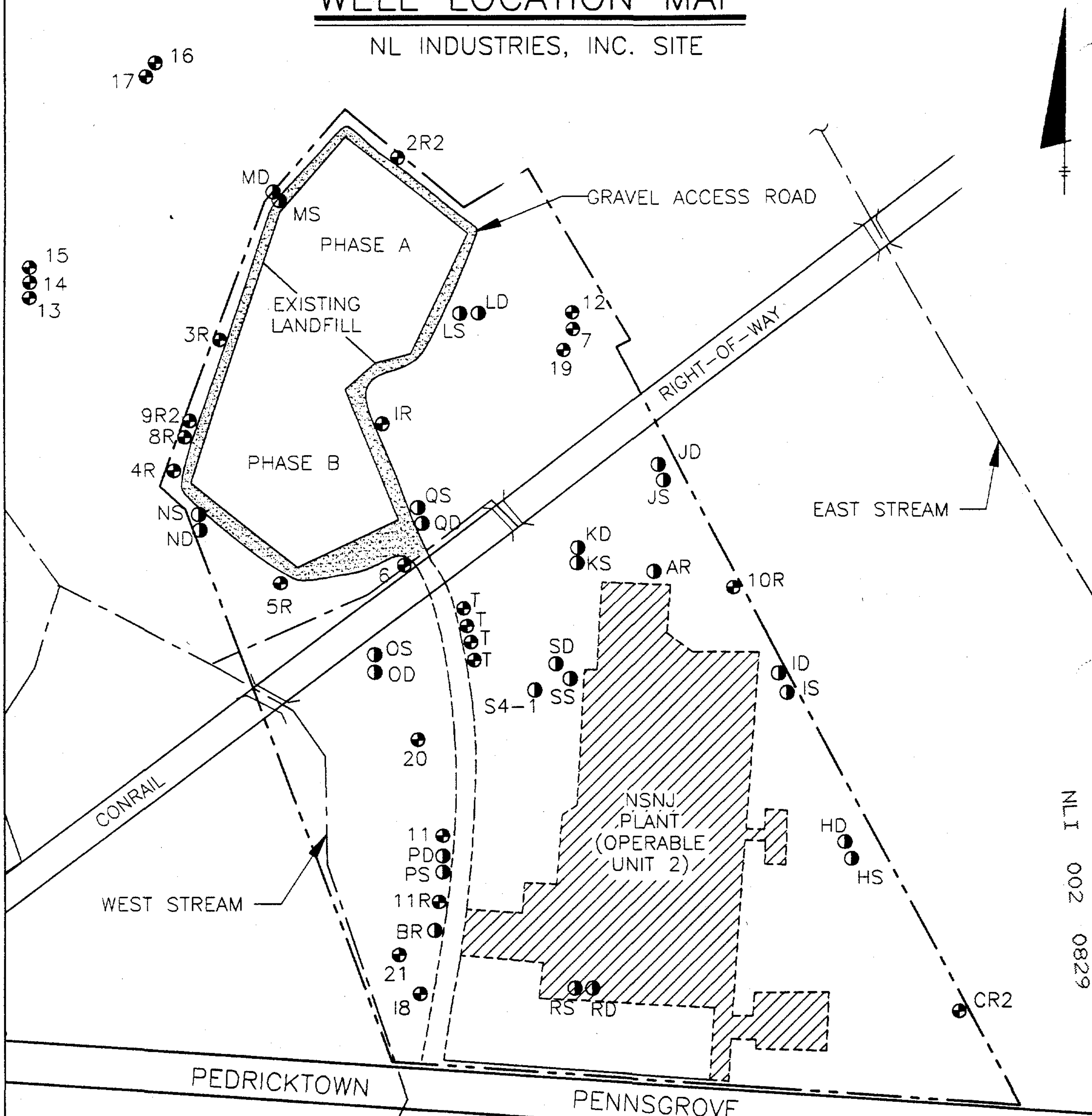
Edison, New Jersey

NLI 002 0828

FIGURE 8

WELL LOCATION MAP

NL INDUSTRIES, INC. SITE



LEGEND

- PLANT AREA
- STREAM
- PROPERTY LINE (APPROX.)
- 18 2" WELL (NESTED PAIR) AND DESIGNATION
- BR 4" WELL AND DESIGNATION
- EXISTING CULVERT

400 0 400 800

1"=400'-0"

O'BRIEN & GERE ENGINEERS INC.
Edison, New Jersey

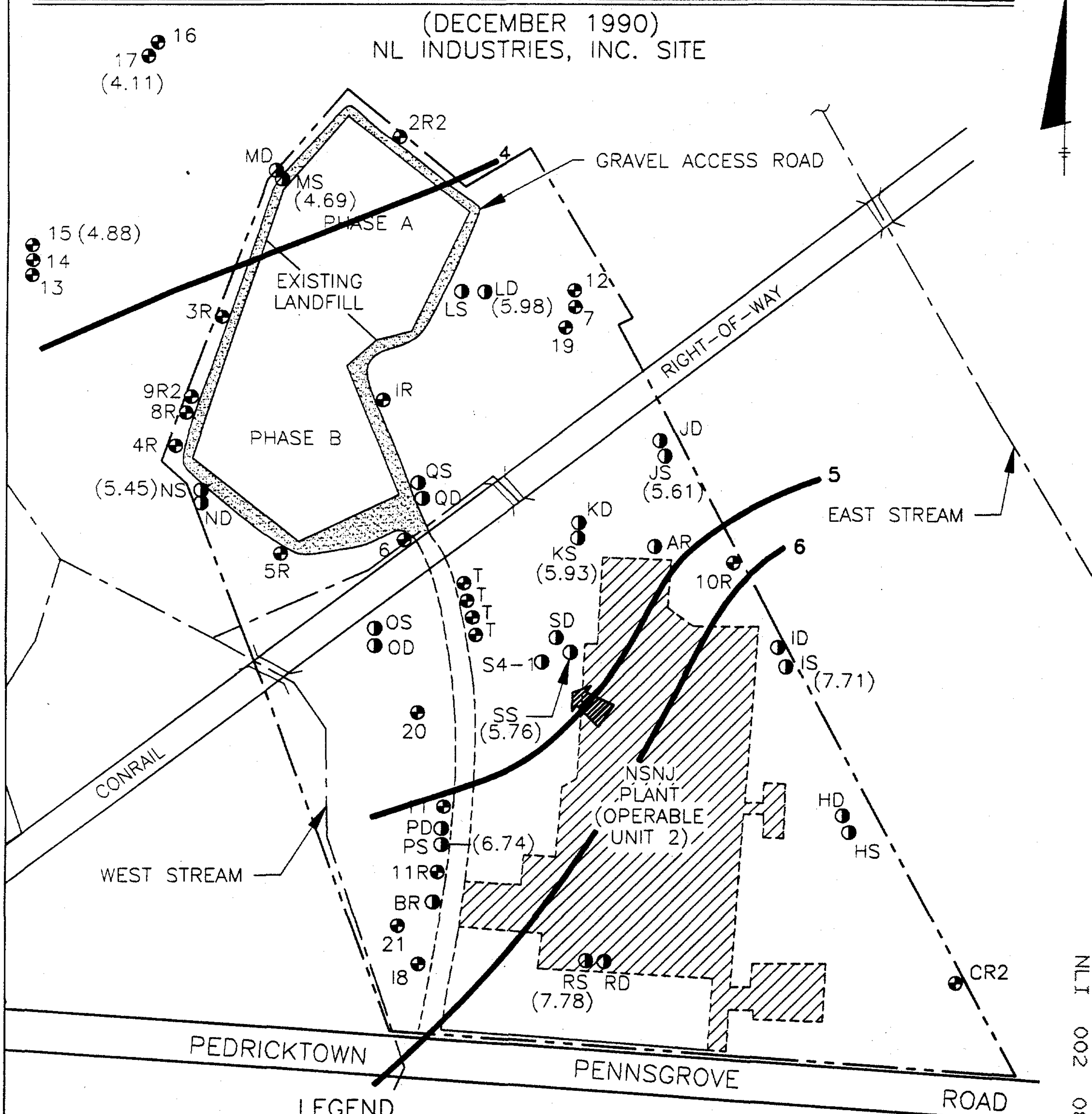
NLI 002 0829

284428-9600

FIGURE 9

SHALLOW UNCONFINED AQUIFER CONTOUR MAP

(DECEMBER 1990)
NL INDUSTRIES, INC. SITE



LEGEND

PLANT AREA

STREAM

PROPERTY LINE (APPROX.)

EXISTING CULVERT

(7.78) ELEVATION ABOVE MSL

5 GROUND WATER CONTOUR AND ELEVATION ABOVE MSL

BR 2" WELL (NESTED PAIR) AND DESIGNATION

18 4" WELL AND DESIGNATION

GROUND WATER FLOW DIRECTION

MSL MEAN SEA LEVEL

400 0 400 800

1"=400'-0"

O'BRIEN & GERE ENGINEERS INC.
Edison, New Jersey

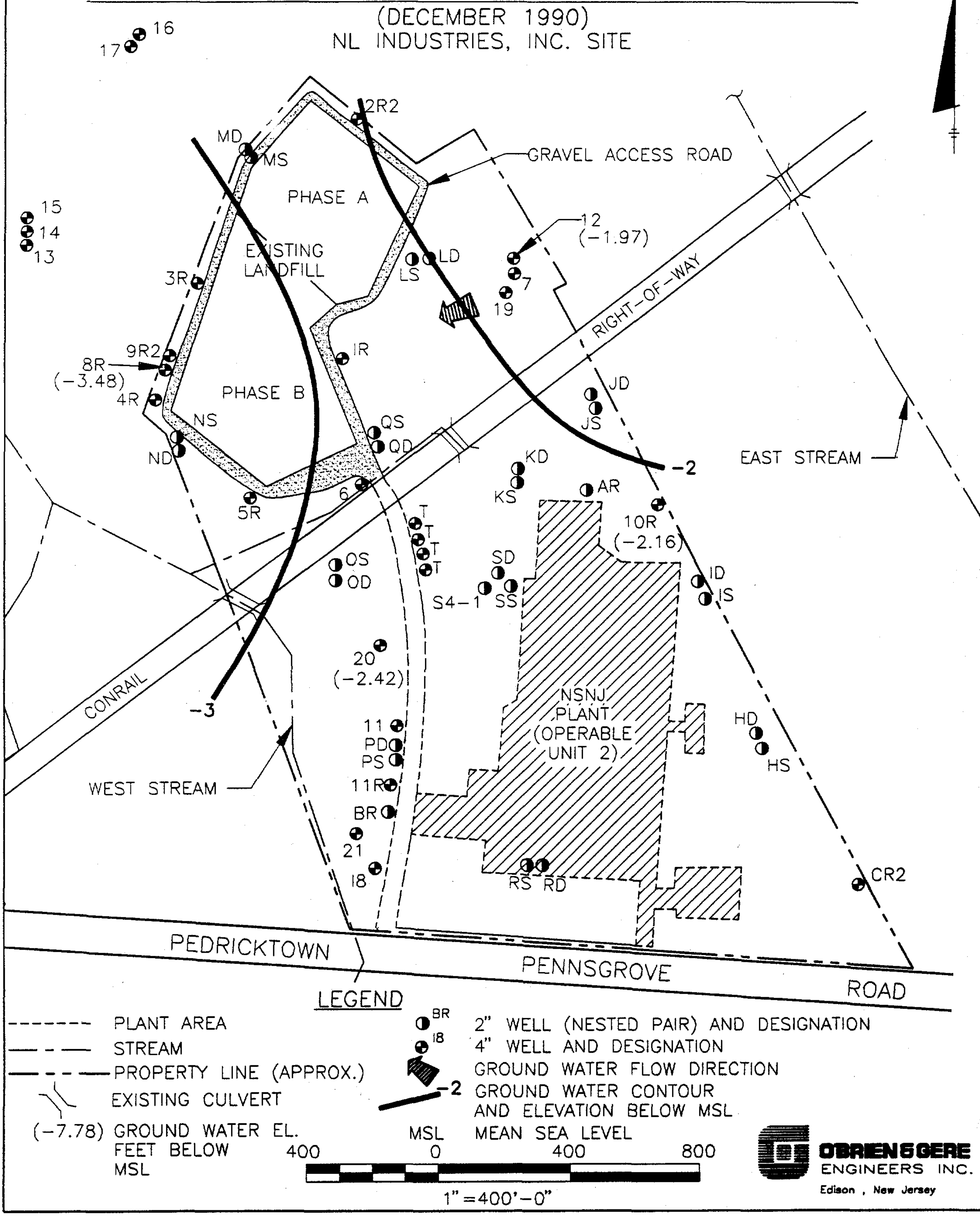
NLI 002 0830

284443-9600

FIGURE 10

FIRST CONFINED AQUIFER CONTOUR MAP

(DECEMBER 1990)
NL INDUSTRIES, INC. SITE

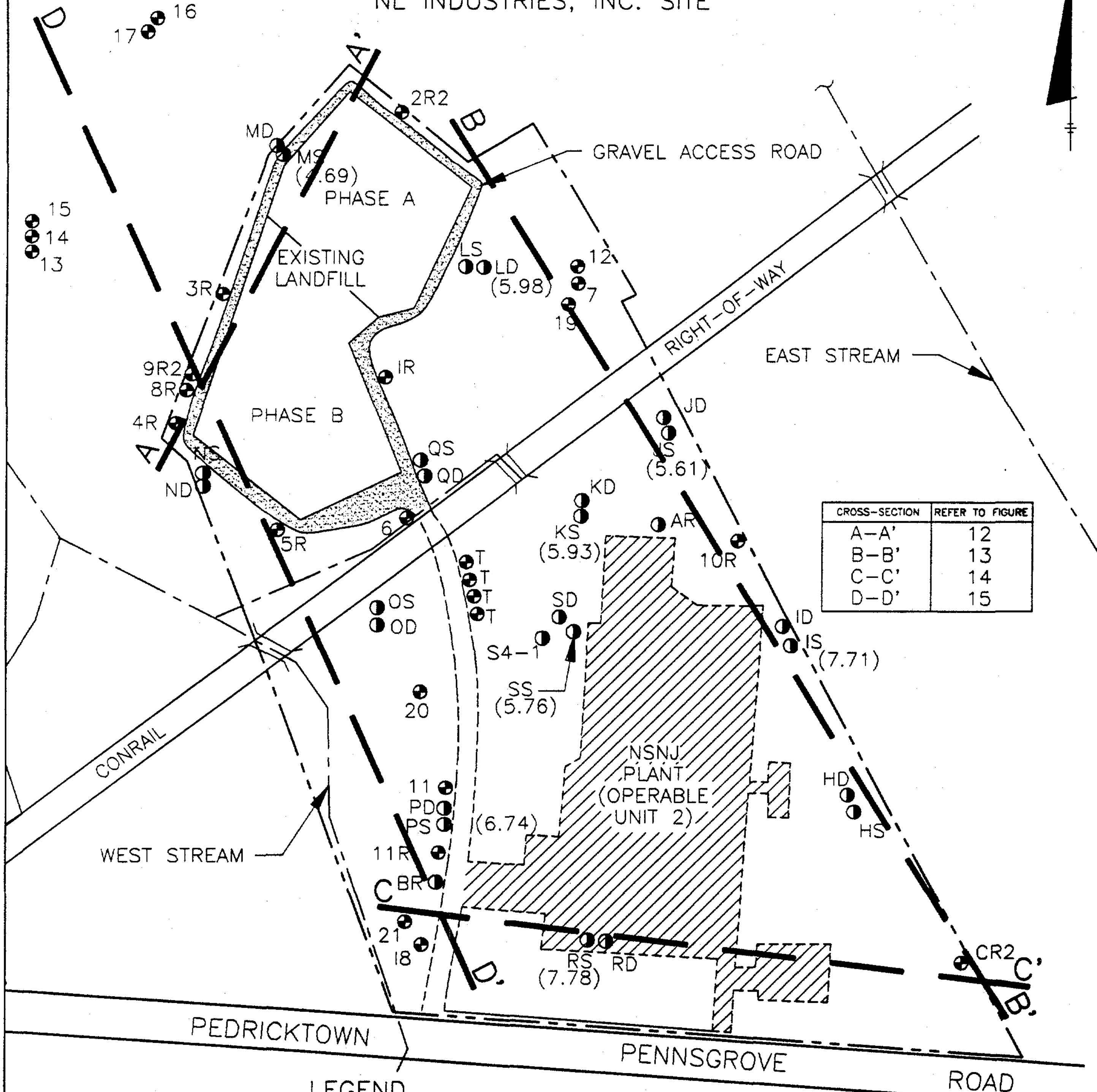


NLI 002 0831

FIGURE 11

GEOLOGIC CROSS-SECTIONS

NL INDUSTRIES, INC. SITE



CROSS-SECTION	REFER TO FIGURE
A–A'	12
B–B'	13
C–C'	14
D–D'	15

LEGEND

- PLANT AREA
- STREAM
- PROPERTY LINE (APPROX.)
- EXISTING CULVERT
- D' D' CROSS-SECTION DESIGNATION
- BR 2" WELL (NESTED PAIR) AND DESIGNATION
- 18 4" WELL AND DESIGNATION

400 0 400 800

1"=400'-0"

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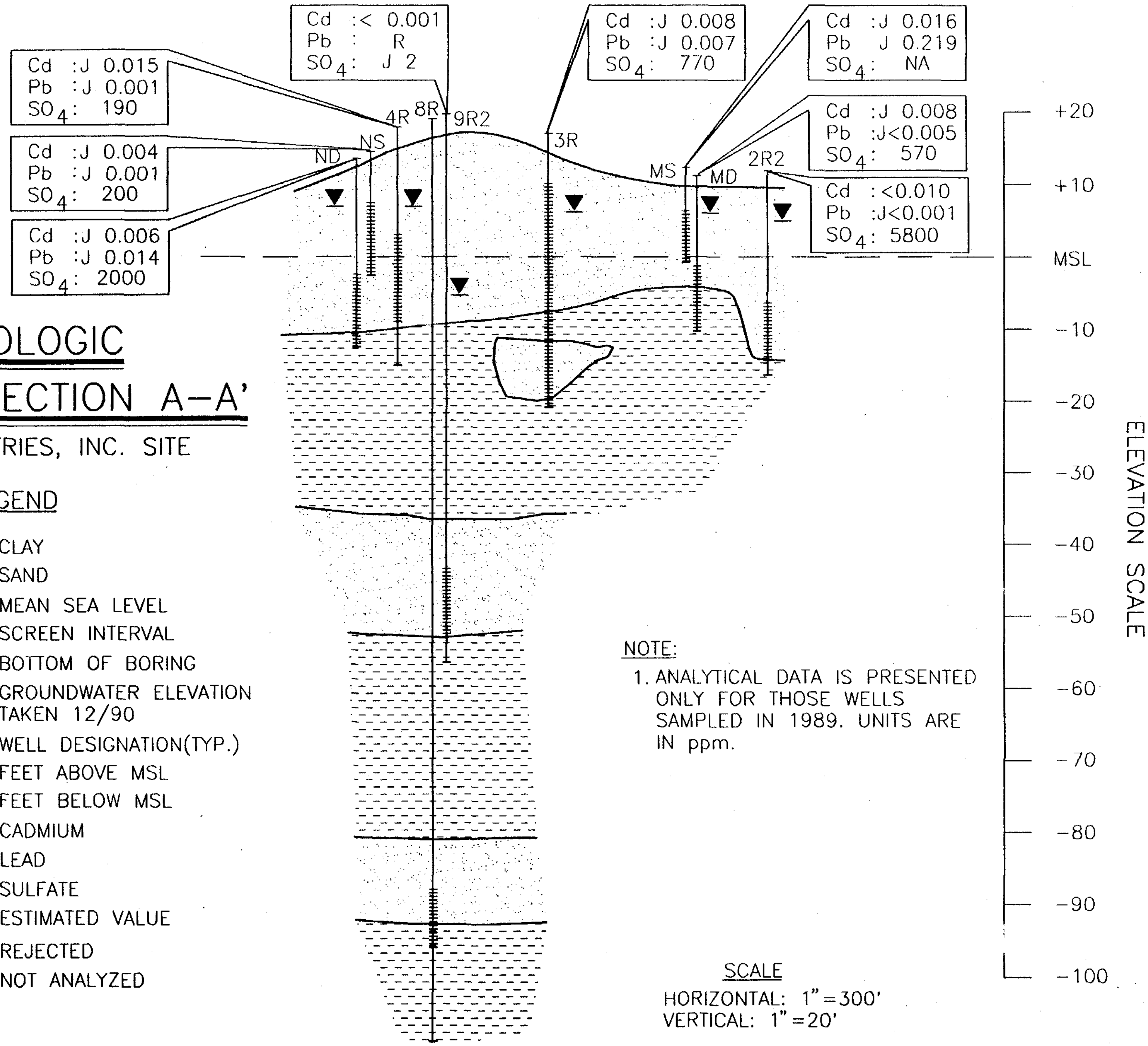
Edison, New Jersey

NLI 002 0832

284418-1



GEOLOGIC CROSS-SECTION A-A'

NL INDUSTRIES, INC. SITE

LEGEND

	CLAY
	SAND
MSL	MEAN SEA LEVEL
	SCREEN INTERVAL
	BOTTOM OF BORING
▼	GROUNDWATER ELEVATION TAKEN 12/90
3R	WELL DESIGNATION(TYP.)
+10	FEET ABOVE MSL
-10	FEET BELOW MSL
Cd	CADMIUM
Pb	LEAD
SO_4	SULFATE
J	ESTIMATED VALUE
R	REJECTED
NA	NOT ANALYZED

NOTE:

1. ANALYTICAL DATA IS PRESENTED ONLY FOR THOSE WELLS SAMPLED IN 1989. UNITS ARE IN ppm.

SCALE

HORIZONTAL: 1" = 300'
VERTICAL: 1" = 20'

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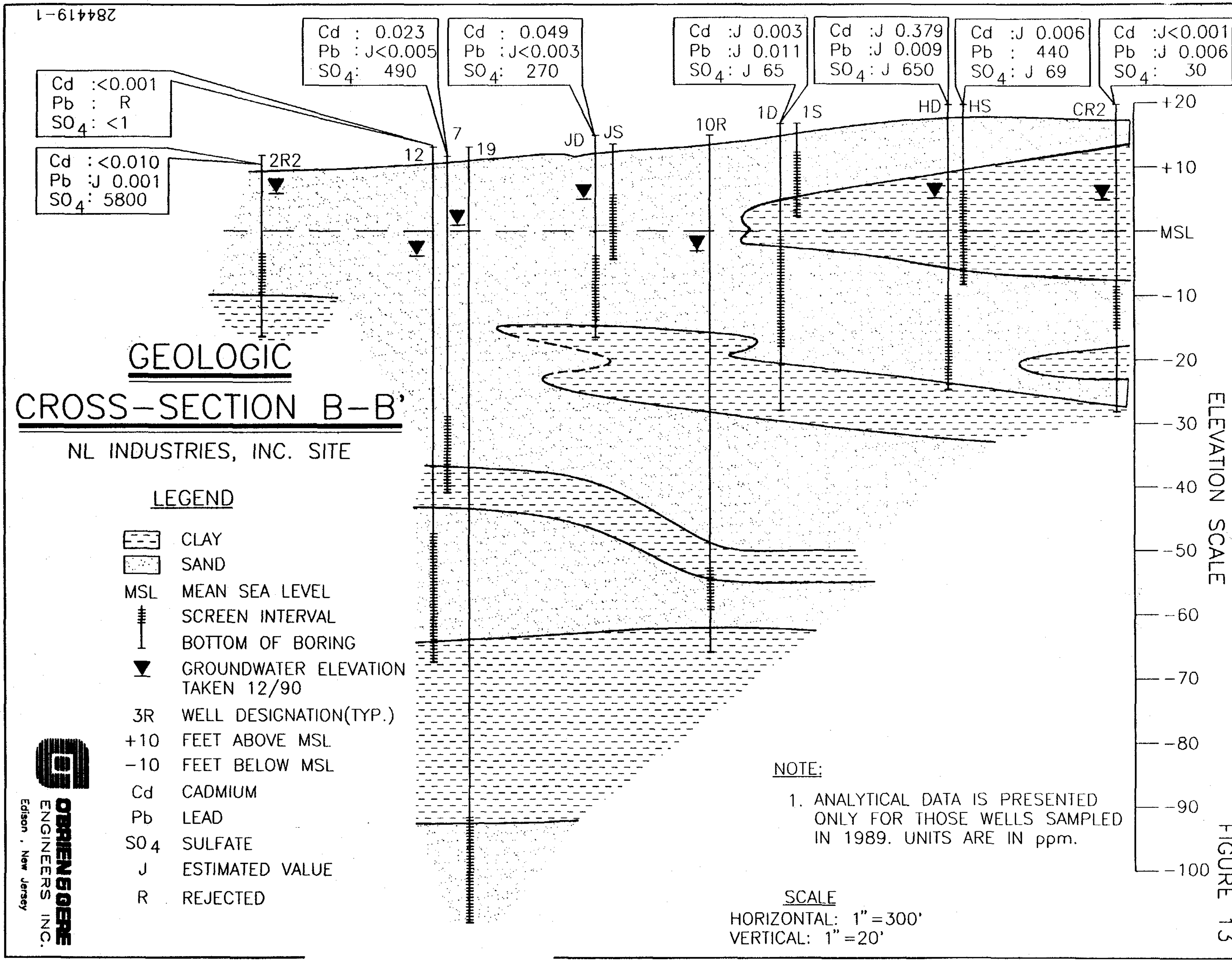
Edison, New Jersey

FIGURE 12

NLI 002 0833



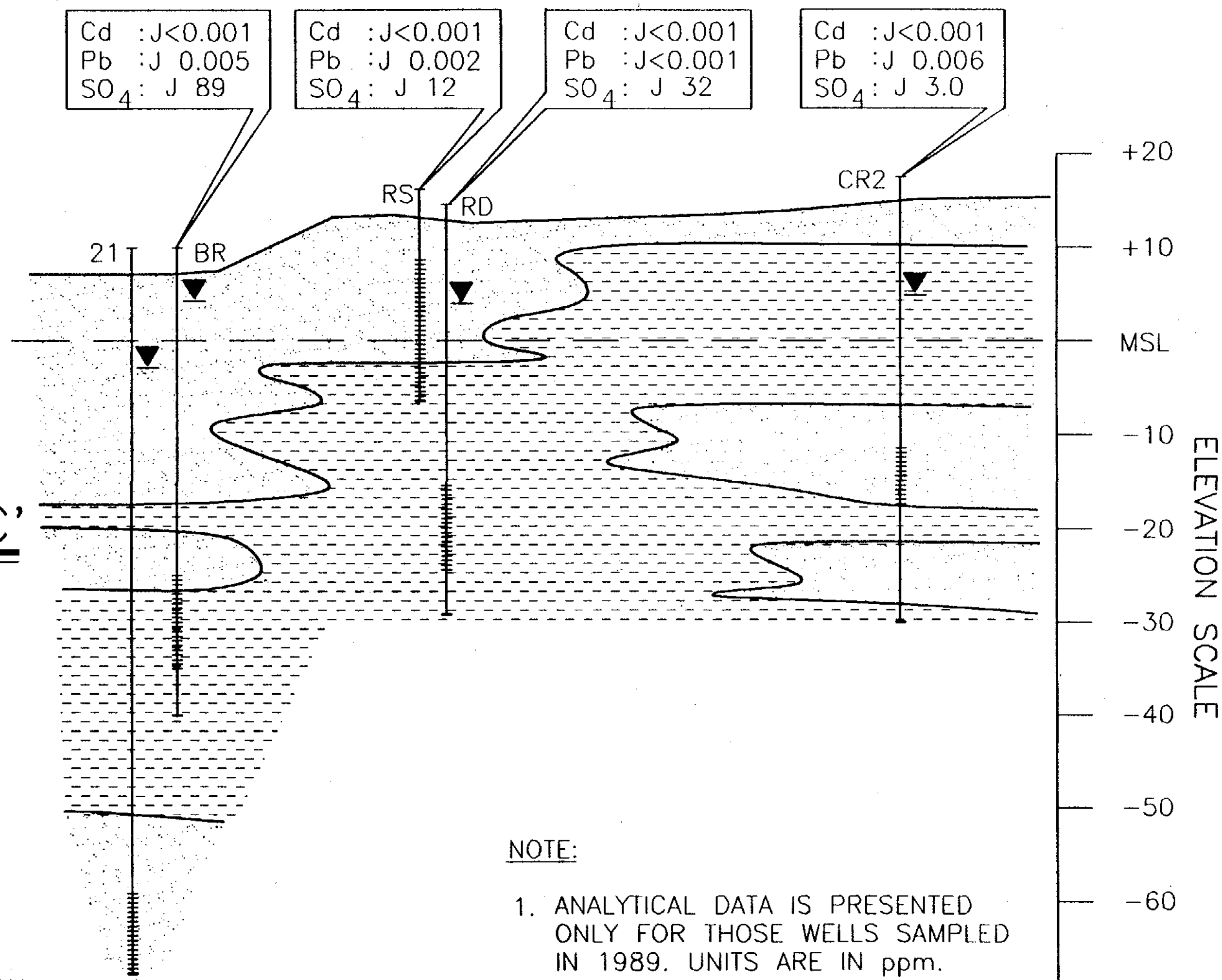
284419-1
Cd :<0.001
Pb : R
SO4: <1
Cd :<0.010
Pb :J 0.001
SO4: 5800
Cd : 0.023
Pb : J<0.005
SO4: 490
Cd : 0.049
Pb : J<0.003
SO4: 270
Cd :J 0.003
Pb :J 0.011
SO4: J 65
Cd :J 0.379
Pb :J 0.009
SO4: J 650
Cd :J 0.006
Pb : 440
SO4: J 69
Cd :J<0.001
Pb :J 0.006
SO4: 30
2R2
12
7
19
JD
JS
10R
1D
1S
HD
HS
CR2
+20
+10
MSL
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
ELEVATION SCALE
GEOLOGIC
CROSS-SECTION B-B'
NL INDUSTRIES, INC. SITE
LEGEND
CLAY
SAND
MSL MEAN SEA LEVEL
SCREEN INTERVAL
BOTTOM OF BORING
GROUNDWATER ELEVATION TAKEN 12/90
3R WELL DESIGNATION(TYP.)
+10 FEET ABOVE MSL
-10 FEET BELOW MSL
Cd CADMIUM
Pb LEAD
SO4 SULFATE
J ESTIMATED VALUE
R REJECTED
O'BRIEN & GERE ENGINEERS INC.
Edison, New Jersey
NOTE:
1. ANALYTICAL DATA IS PRESENTED ONLY FOR THOSE WELLS SAMPLED IN 1989. UNITS ARE IN ppm.
SCALE
HORIZONTAL: 1"=300'
VERTICAL: 1"=20'
FIGURE 13

NL1 002 0834

284440-1

GEOLOGIC CROSS-SECTION C–C'

NL INDUSTRIES, INC. SITE



NOTE:

1. ANALYTICAL DATA IS PRESENTED ONLY FOR THOSE WELLS SAMPLED IN 1989. UNITS ARE IN ppm.

LEGEND

	CLAY
	SAND
MSL	MEAN SEA LEVEL
	SCREEN INTERVAL
	BOTTOM OF BORING
▼	GROUNDWATER ELEVATION TAKEN 12/90
3R	WELL DESIGNATION(TYP.)
+10	FEET ABOVE MSL
−10	FEET BELOW MSL
Cd	CADMIUM
Pb	LEAD
SO_4	SULFATE
J	ESTIMATED VALUE

SCALE
HORIZONTAL: 1" = 300'
VERTICAL: 1" = 20'

FIGURE 14

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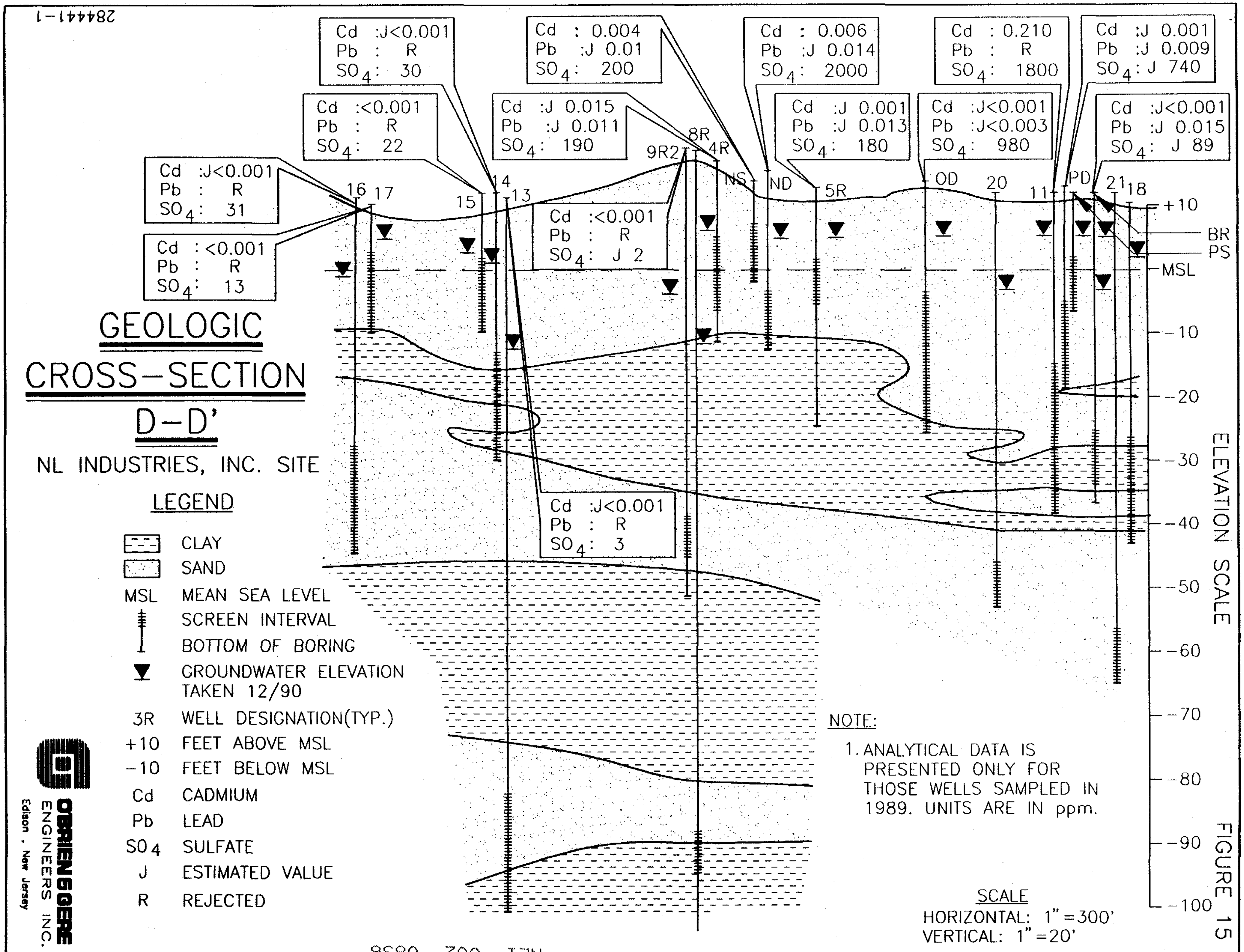
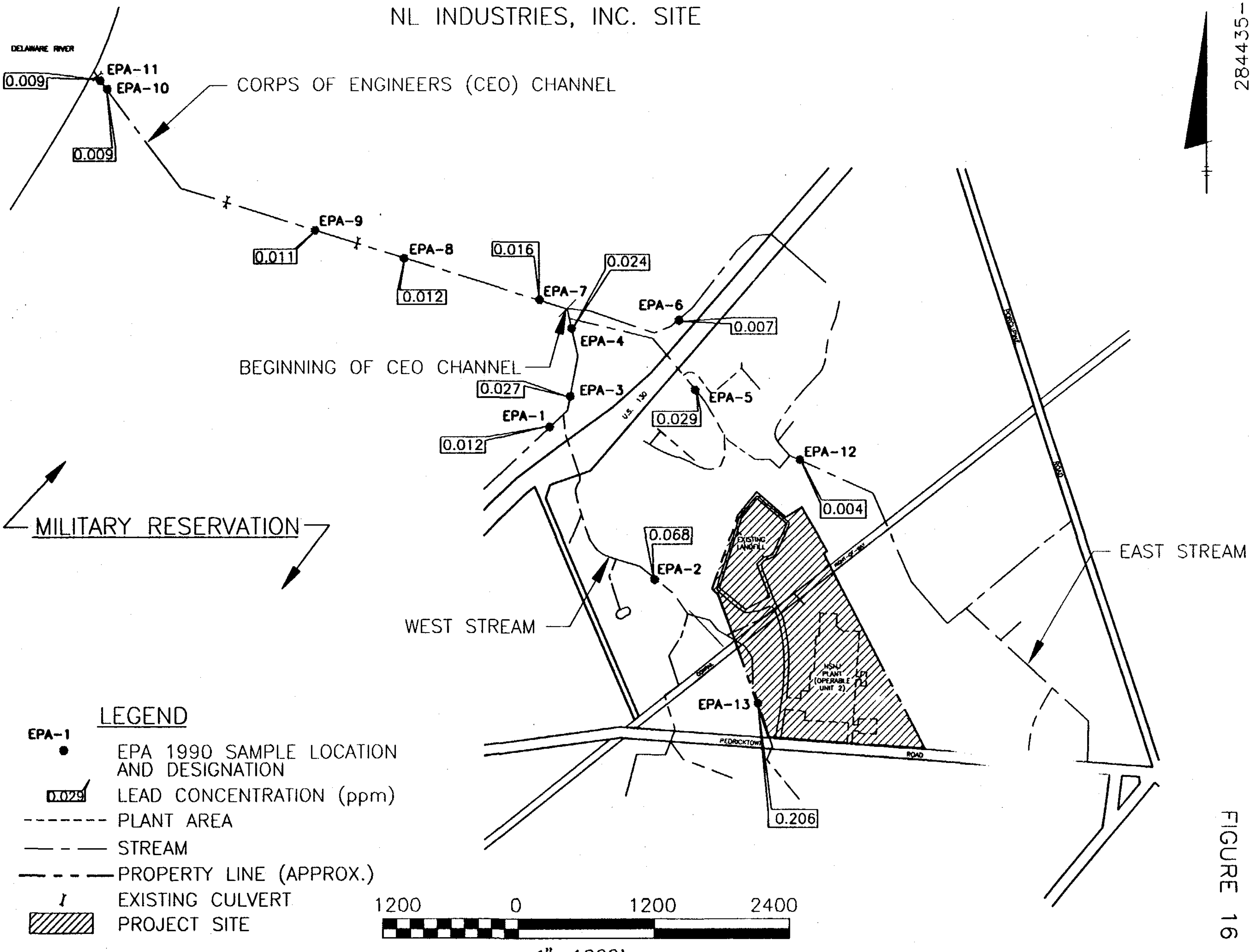

GEOLOGIC
CROSS-SECTION
D-D'
NL INDUSTRIES, INC. SITE
LEGEND
CLAY
SAND
MSL MEAN SEA LEVEL
SCREEN INTERVAL
BOTTOM OF BORING
GROUNDWATER ELEVATION TAKEN 12/90
3R WELL DESIGNATION(TYP.)
+10 FEET ABOVE MSL
−10 FEET BELOW MSL
Cd CADMIUM
Pb LEAD
SO4 SULFATE
J ESTIMATED VALUE
R REJECTED
O'BRIEN & GERE ENGINEERS INC.
Edison, New Jersey
Cd :J<0.001 Pb : R SO4: 31
Cd : <0.001 Pb : R SO4: 13
Cd :<0.001 Pb : R SO4: 22
Cd :J<0.001 Pb : R SO4: 30
Cd : 0.004 Pb :J 0.01 SO4: 200
Cd :J 0.015 Pb :J 0.011 SO4: 190
Cd :<0.001 Pb : R SO4: J 2
Cd :J<0.001 Pb : R SO4: 3
Cd : 0.006 Pb :J 0.014 SO4: 2000
Cd :J 0.001 Pb :J 0.013 SO4: 180
Cd : 0.210 Pb : R SO4: 1800
Cd :J<0.001 Pb :J<0.003 SO4: 980
Cd :J 0.001 Pb :J 0.009 SO4: J 740
Cd :J<0.001 Pb :J 0.015 SO4: J 89
16 17 15 14 13 9R2 8R 4R NS ND 5R OD 20 11 PD 21 18
BR
PS
MSL
+10
−10
−20
−30
−40
−50
−60
−70
−80
−90
−100
ELEVATION SCALE
NOTE:
1. ANALYTICAL DATA IS PRESENTED ONLY FOR THOSE WELLS SAMPLED IN 1989. UNITS ARE IN ppm.
SCALE
HORIZONTAL: 1" = 300'
VERTICAL: 1" = 20'
FIGURE 15
284441-1
NL.I 002 0836

1990 SURFACE WATER LEAD CONCENTRATIONS

NL INDUSTRIES, INC. SITE



O'BRIEN & GERE ENGINEERS INC.
Edison, New Jersey

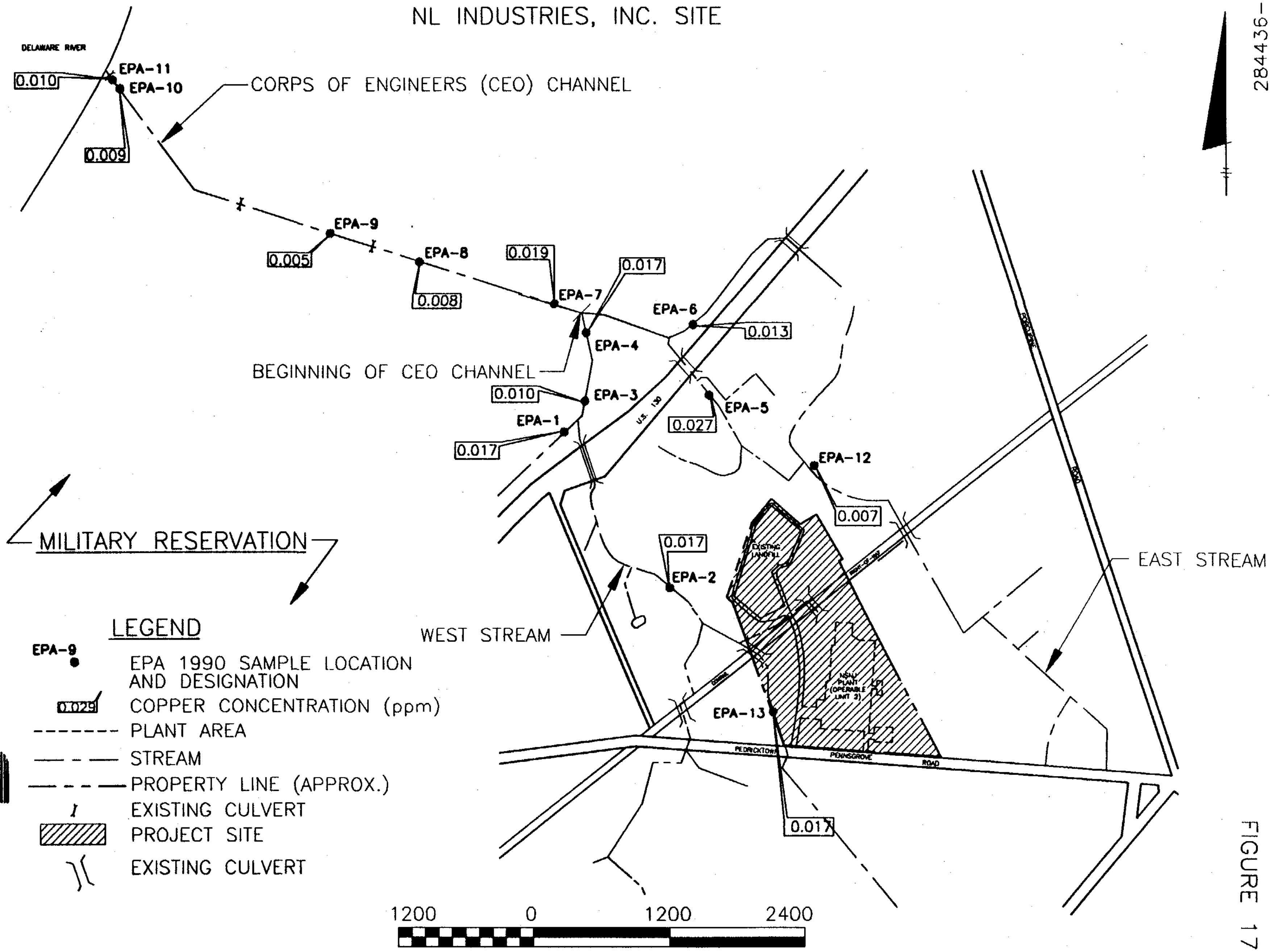
FIGURE 16

284435-9600

NL1 002 0837

1990 SURFACE WATER COPPER CONCENTRATIONS

NL INDUSTRIES, INC. SITE



O'BRIEN & GERE ENGINEERS INC.
Edison, New Jersey

284436-9600

FIGURE 17

NL I 002 0838

1990 SURFACE WATER ZINC CONCENTRATIONS

NL INDUSTRIES, INC. SITE

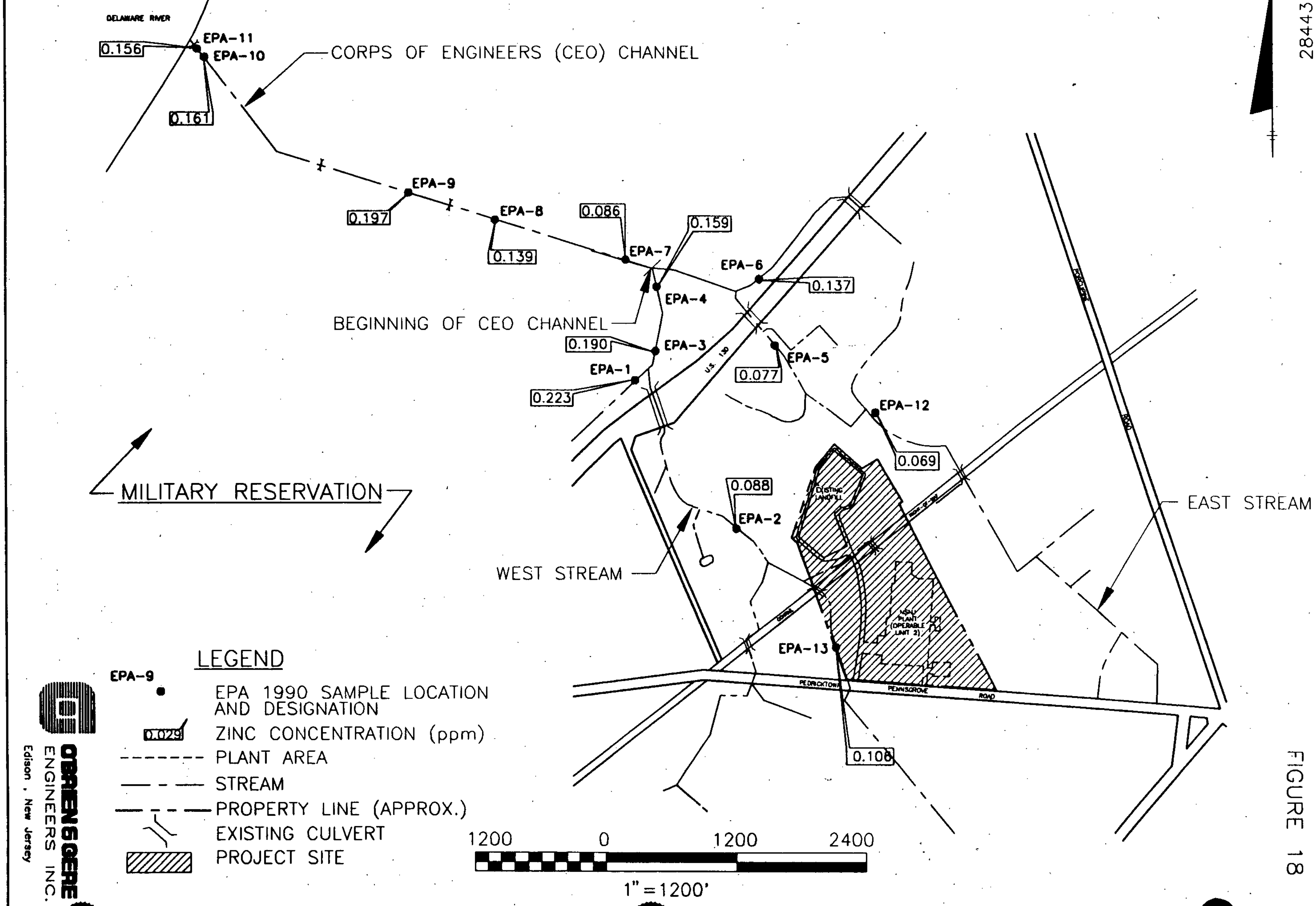
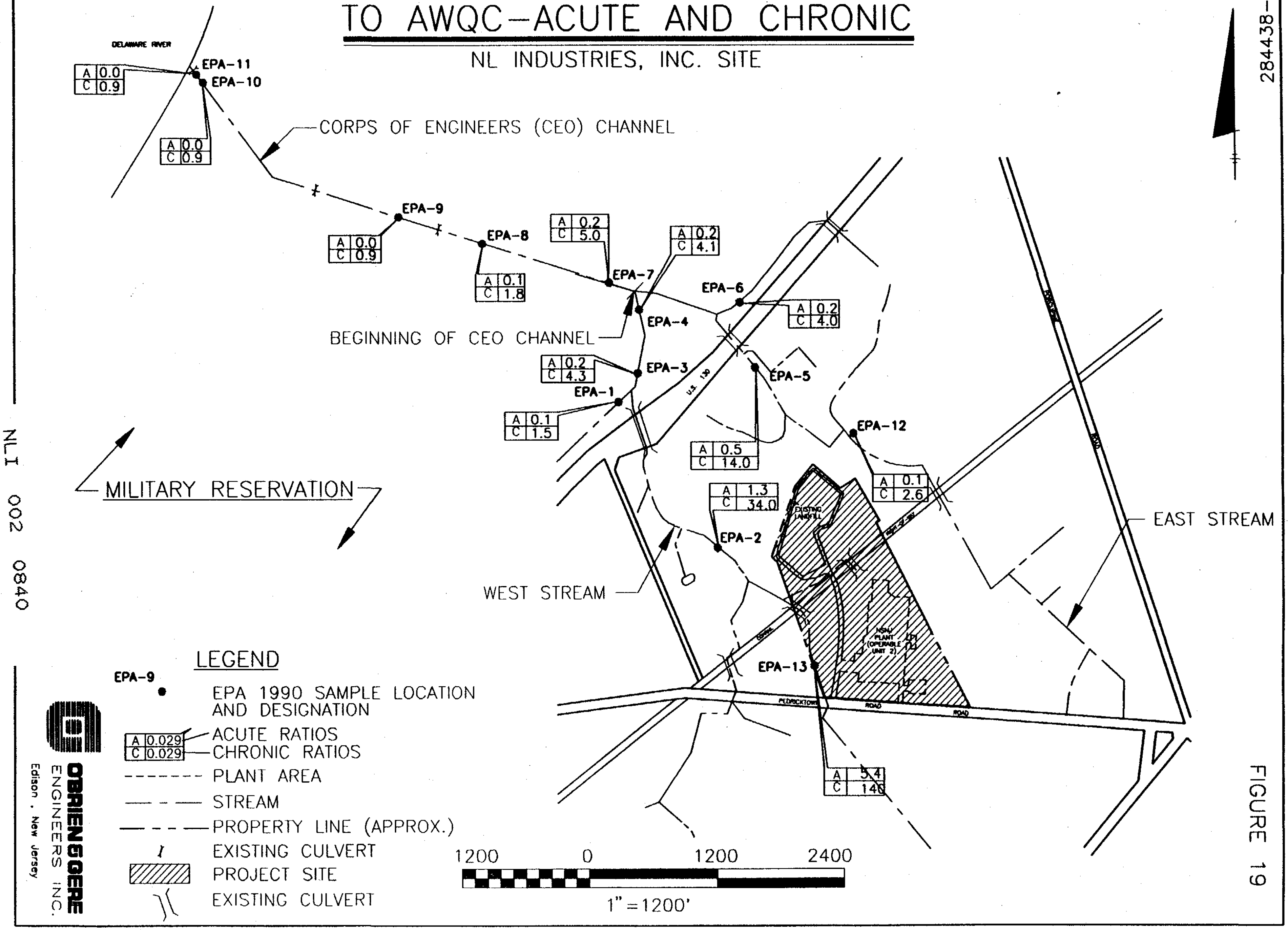


FIGURE 18

1990 SURFACE WATER LEAD CONCENTRATIONS RATIOS TO AWQC–ACUTE AND CHRONIC

NL INDUSTRIES, INC. SITE



284438-9600

NLI 002 0840

FIGURE 19

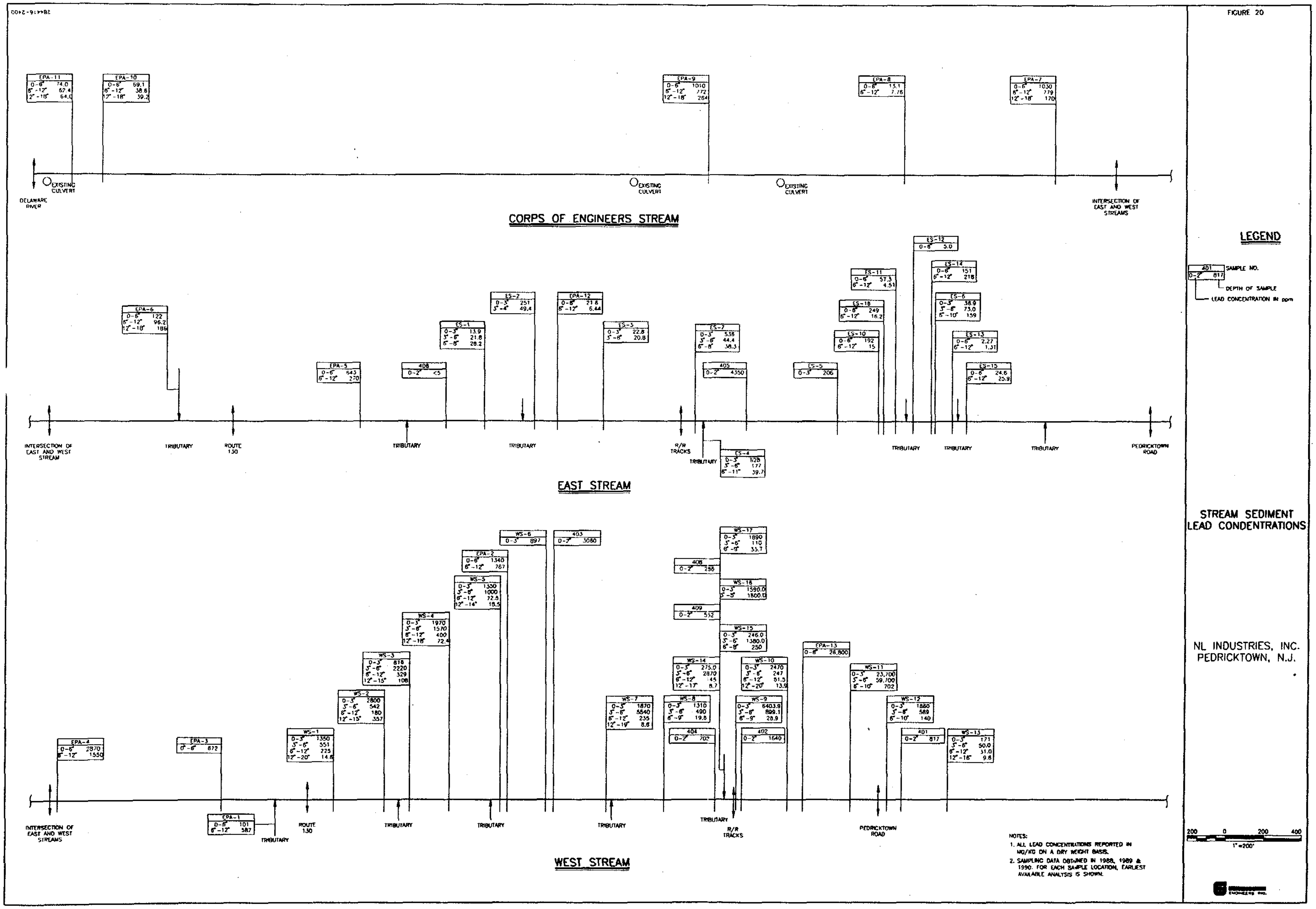
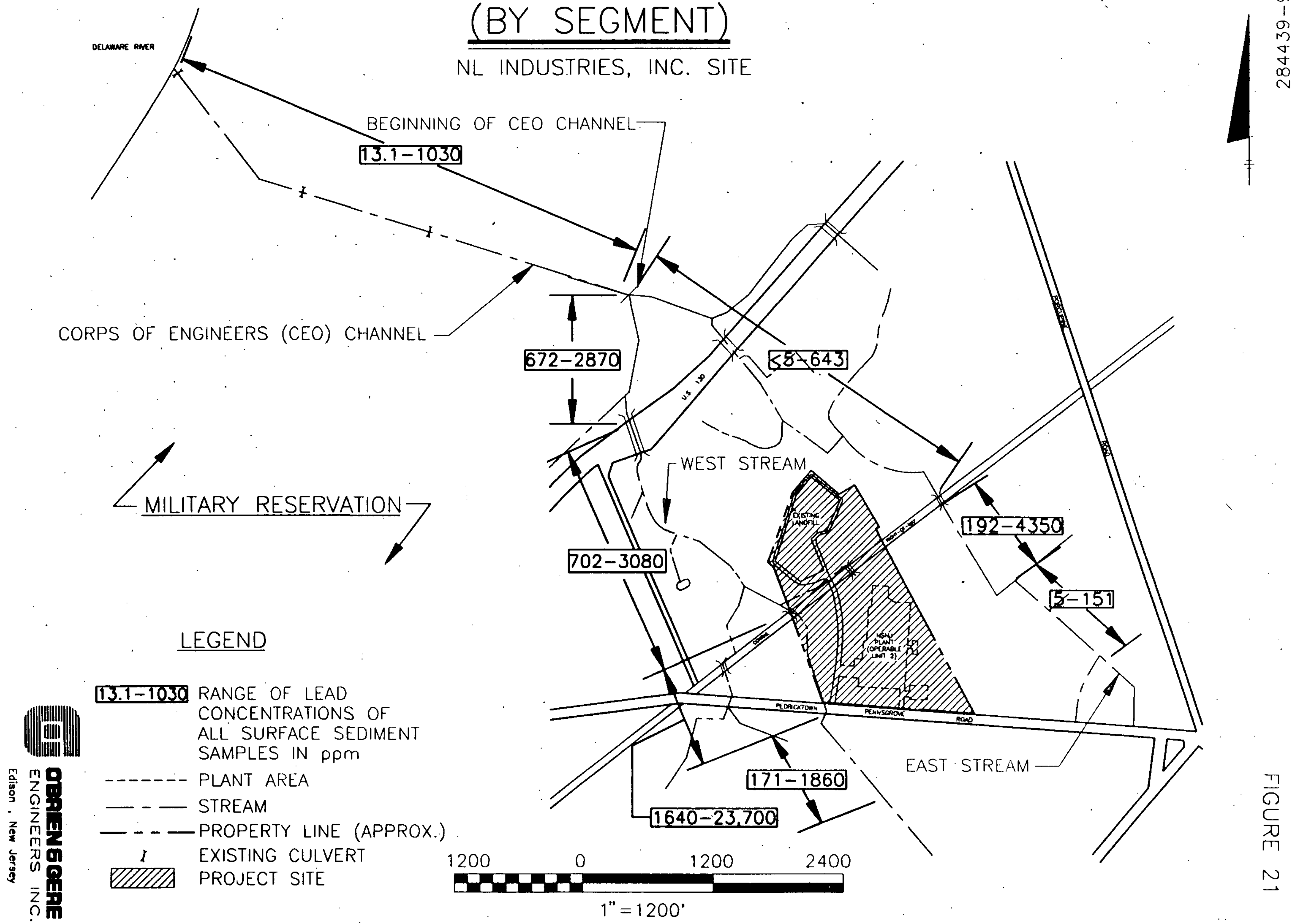


FIGURE 20
CORPS OF ENGINEERS STREAM
EAST STREAM
WEST STREAM
DELAWARE RIVER
EXISTING CULVERT
INTERSECTION OF EAST AND WEST STREAMS
TRIBUTARY
ROUTE 130
R/R TRACKS
PEDRICKTOWN ROAD
LEGEND
SAMPLE NO.
DEPTH OF SAMPLE
LEAD CONCENTRATION IN ppm
STREAM SEDIMENT LEAD CONDENTRATIONS
NL INDUSTRIES, INC.
PEDRICKTOWN, N.J.
NOTES:
1. ALL LEAD CONCENTRATIONS REPORTED IN MG/KG ON A DRY WEIGHT BASIS.
2. SAMPLING DATA OBTAINED IN 1988, 1989 & 1990. FOR EACH SAMPLE LOCATION, EARLIEST AVAILABLE ANALYSIS IS SHOWN.
200 0 200 400
1" =200'

NLI 002 0841

RANGE OF SEDIMENT LEAD CONCENTRATIONS
(BY SEGMENT)

NL INDUSTRIES, INC. SITE



284439-9600

FIGURE 21

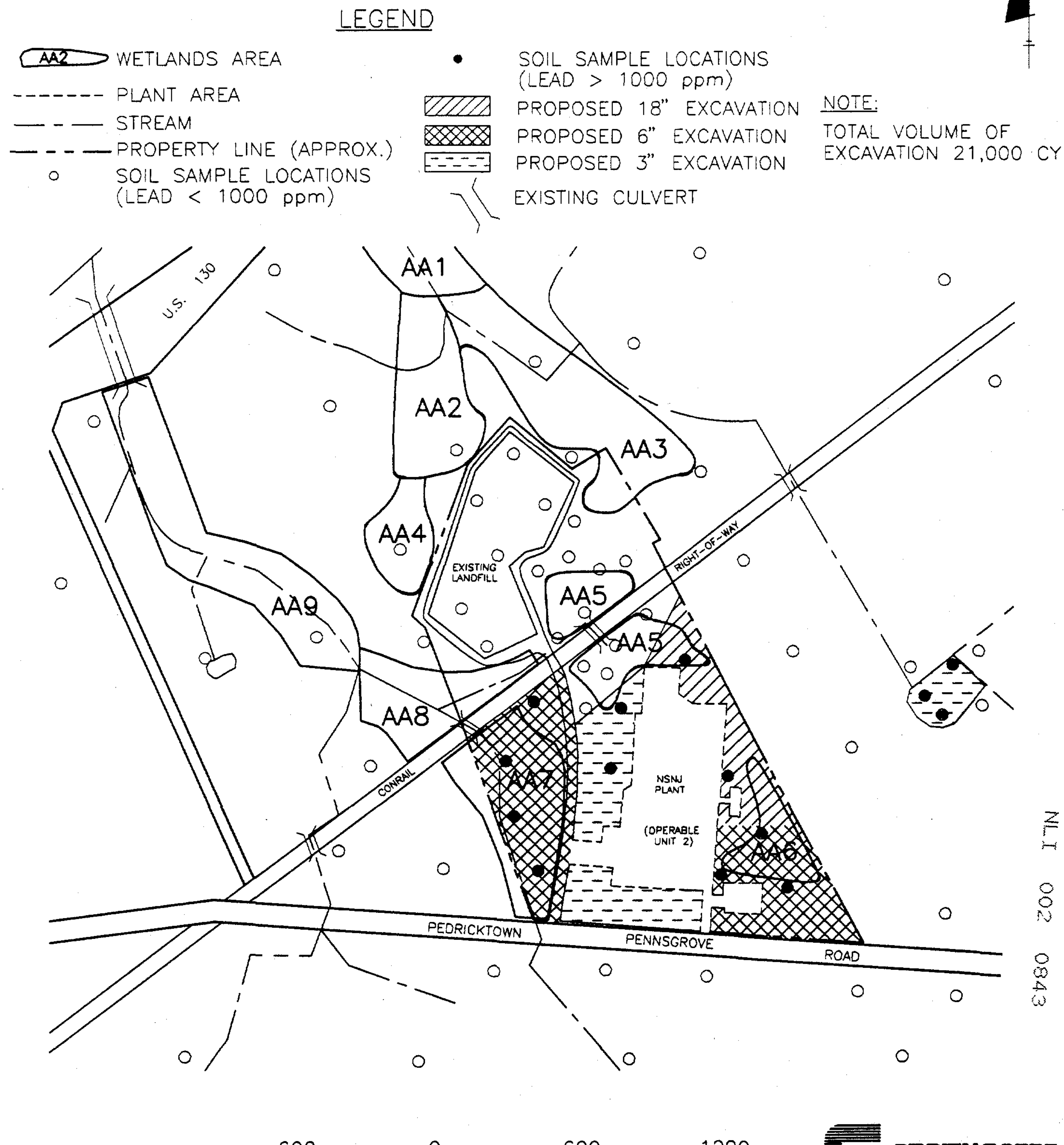
NLI 002 0842

28409-9600

FIGURE 23

SOIL EXCAVATION ZONES
1000 ppm LEAD (1) LIMIT

NL INDUSTRIES, INC. SITE



(1) BASED ON MAXIMUM OBSERVED CONCENTRATION AT SOIL SAMPLE LOCATION.

O'BRIEN & GERE ENGINEERS INC.
Edison, New Jersey

NL I 002 0843

28406-9600

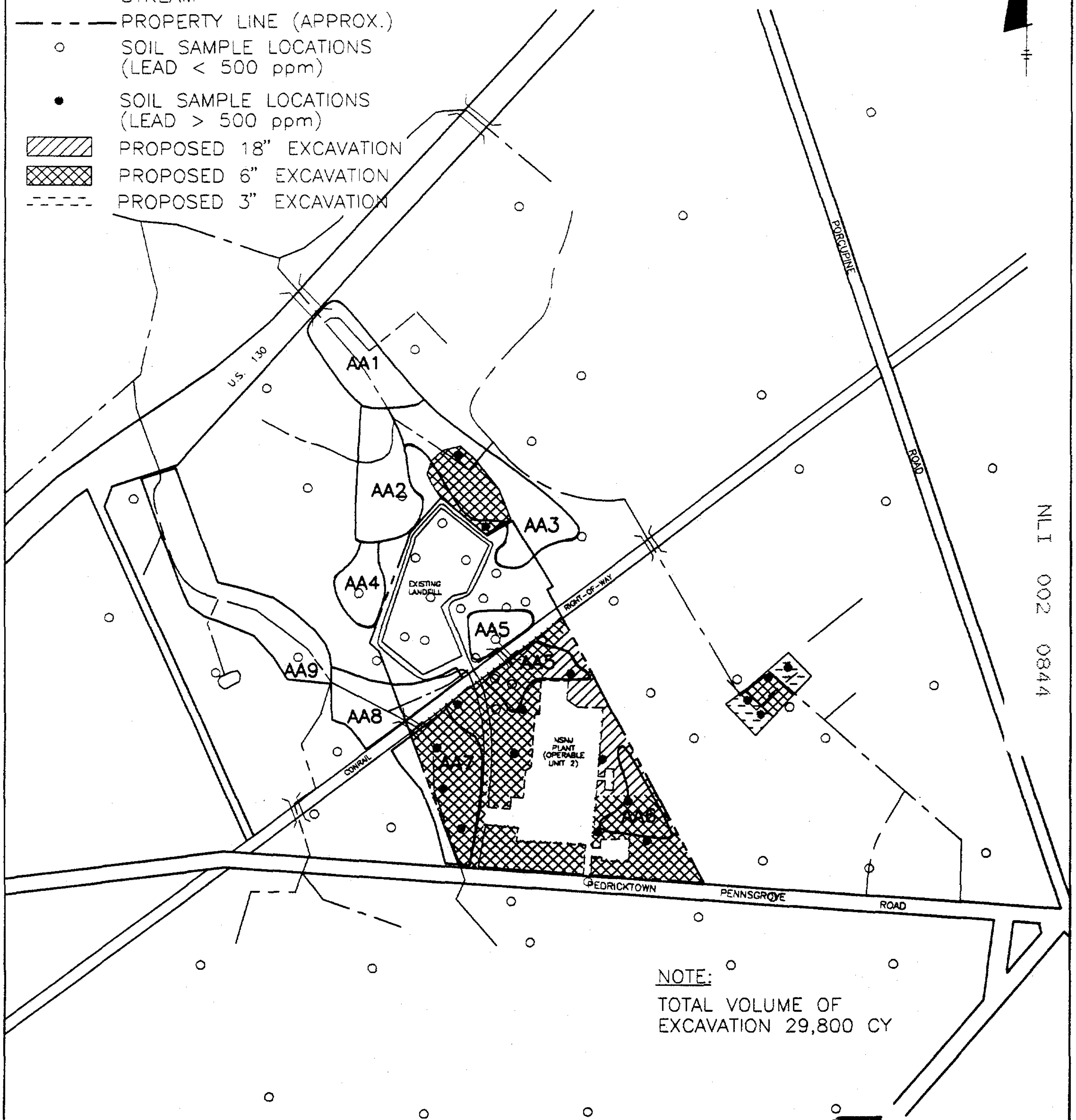
SOIL EXCAVATION ZONES
500 ppm LEAD LIMIT

FIGURE 24

NL INDUSTRIES, INC. SITE

LEGEND

AA2 WETLANDS AREA
PLANT AREA
STREAM
PROPERTY LINE (APPROX.)
SOIL SAMPLE LOCATIONS (LEAD < 500 ppm)
SOIL SAMPLE LOCATIONS (LEAD > 500 ppm)
PROPOSED 18" EXCAVATION
PROPOSED 6" EXCAVATION
PROPOSED 3" EXCAVATION



NOTE:
TOTAL VOLUME OF EXCAVATION 29,800 CY

(1) BASED ON MAXIMUM OBSERVED CONCENTRATION AT SOIL SAMPLE LOCATION.

800 0 800 1600

1" =800'

O'BRIEN & GERE ENGINEERS INC.
Edison, New Jersey

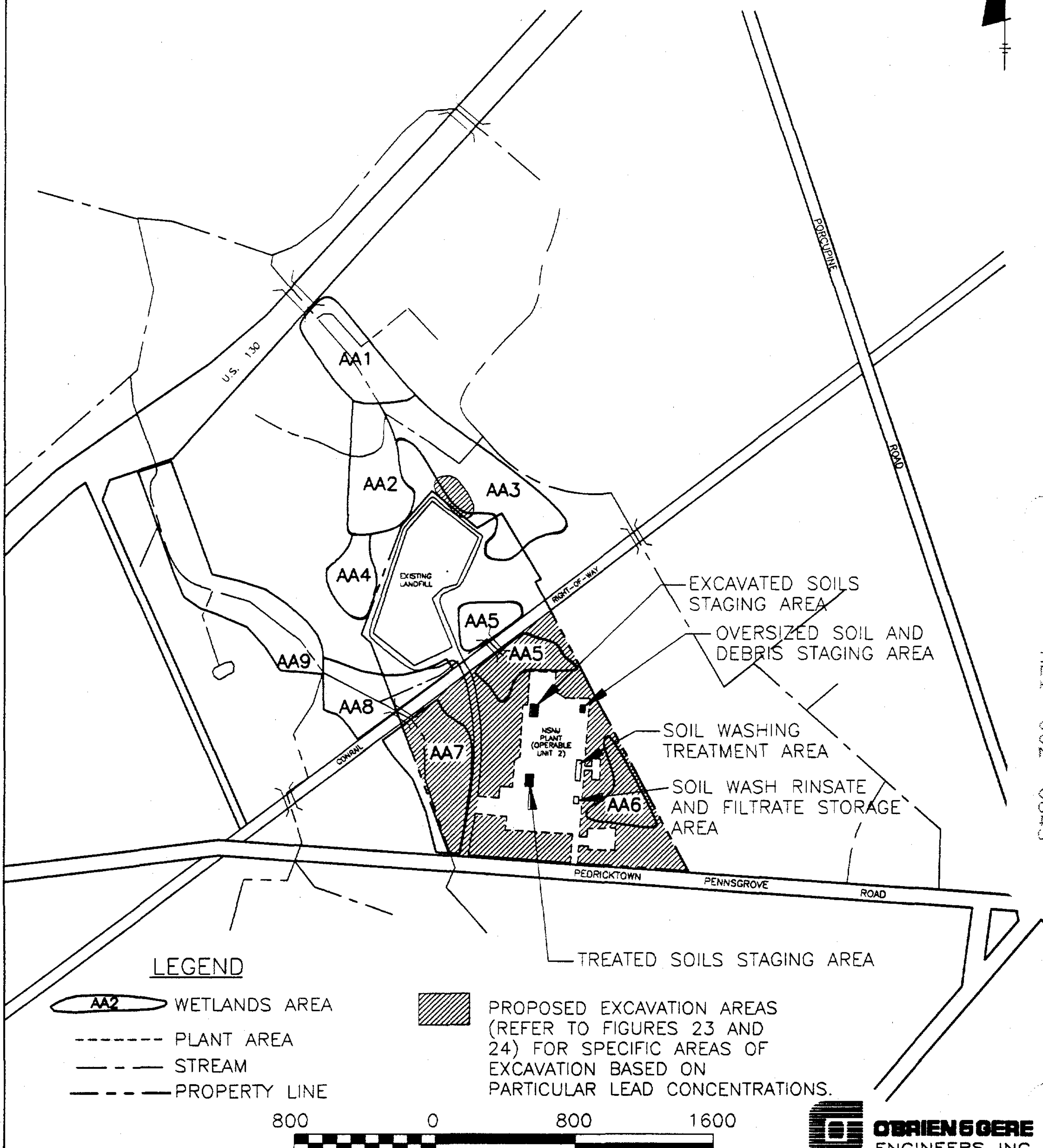
NLI 002 0844

ON-SITE TREATMENT ALTERNATIVE

FIGURE 25

SOIL WASHING

NL INDUSTRIES, INC. SITE



O'BRIEN & GERE ENGINEERS INC.
Edison , New Jersey

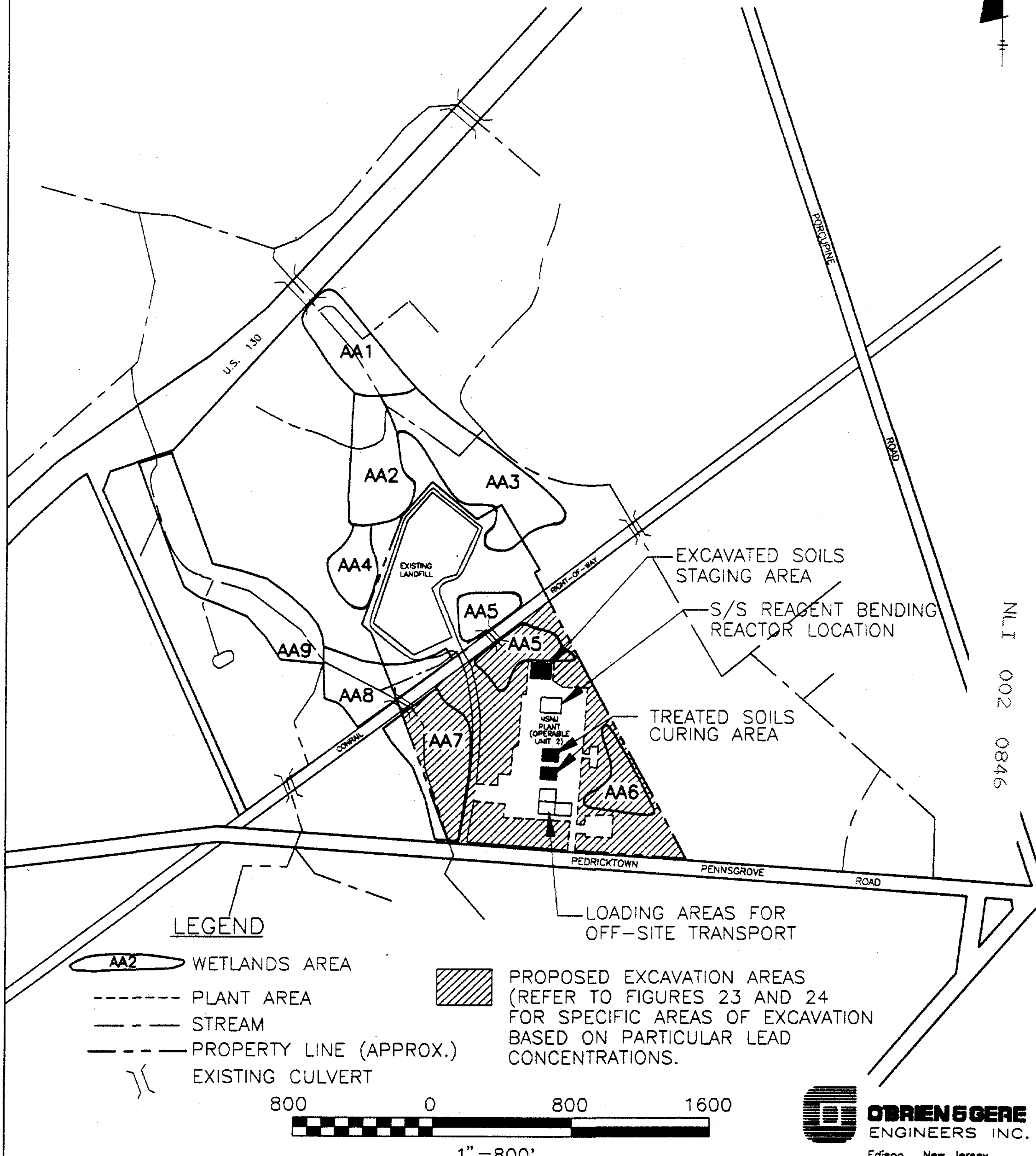
NL I 002 0845

28403-9600

ON-SITE TREATMENT ALTERNATIVE
SOLIDIFICATION/STABILIZATION

FIGURE 26

NL INDUSTRIES, INC. SITE



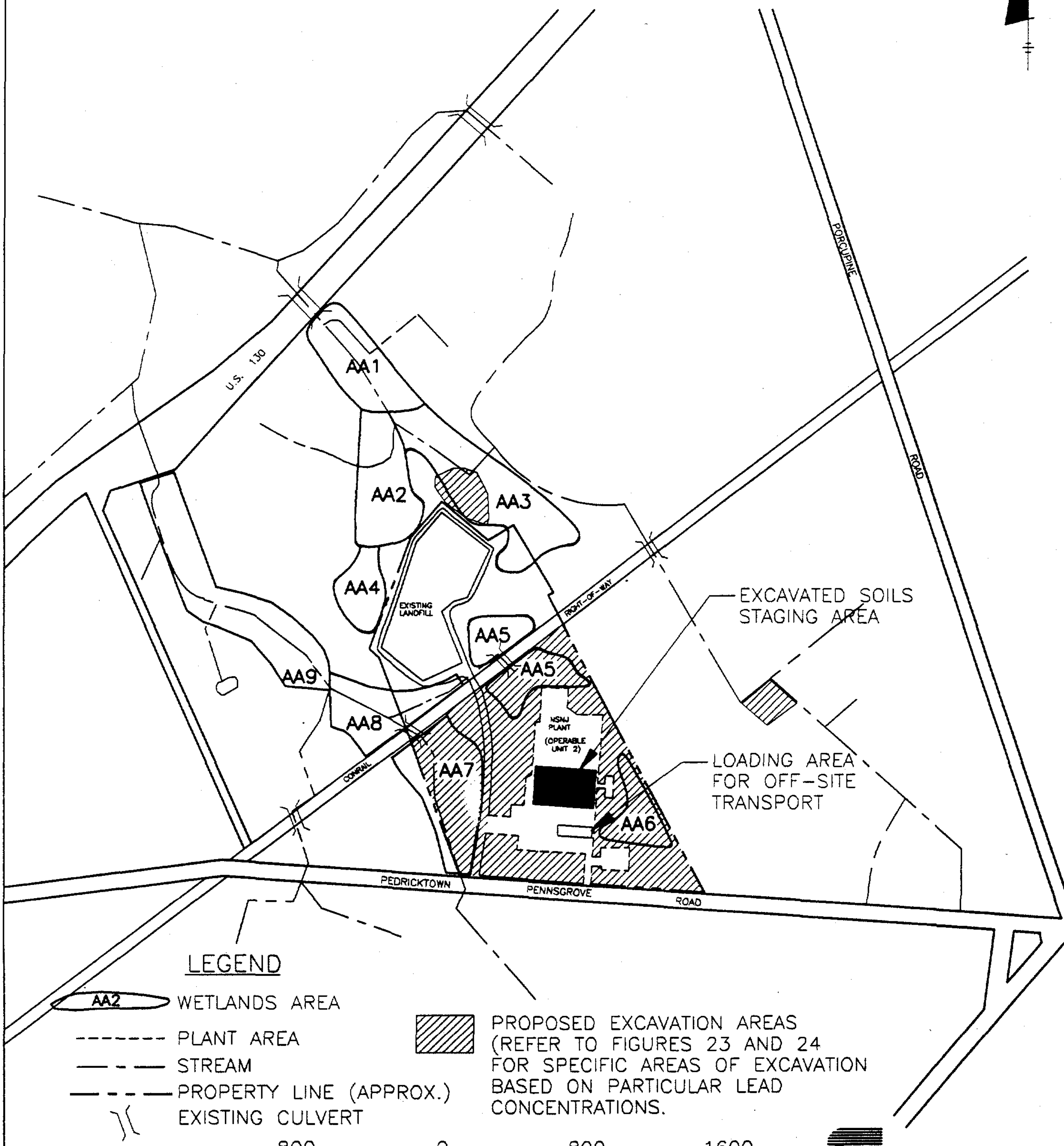
O'BRIEN & GERE ENGINEERS INC.
Edison, New Jersey

NL I 002 0846

FIGURE 27

ON-SITE TREATMENT ALTERNATIVE
EXCAVATION STAGING AREAS

NL INDUSTRIES, INC. SITE



O'BRIEN & GERE ENGINEERS INC.
Edison, New Jersey

NLI 002 0847

28405-9600

FIGURE 28

PROPOSED ON-SITE CONSOLIDATION AREA LOCATION

NL INDUSTRIES, INC. SITE

LEGEND

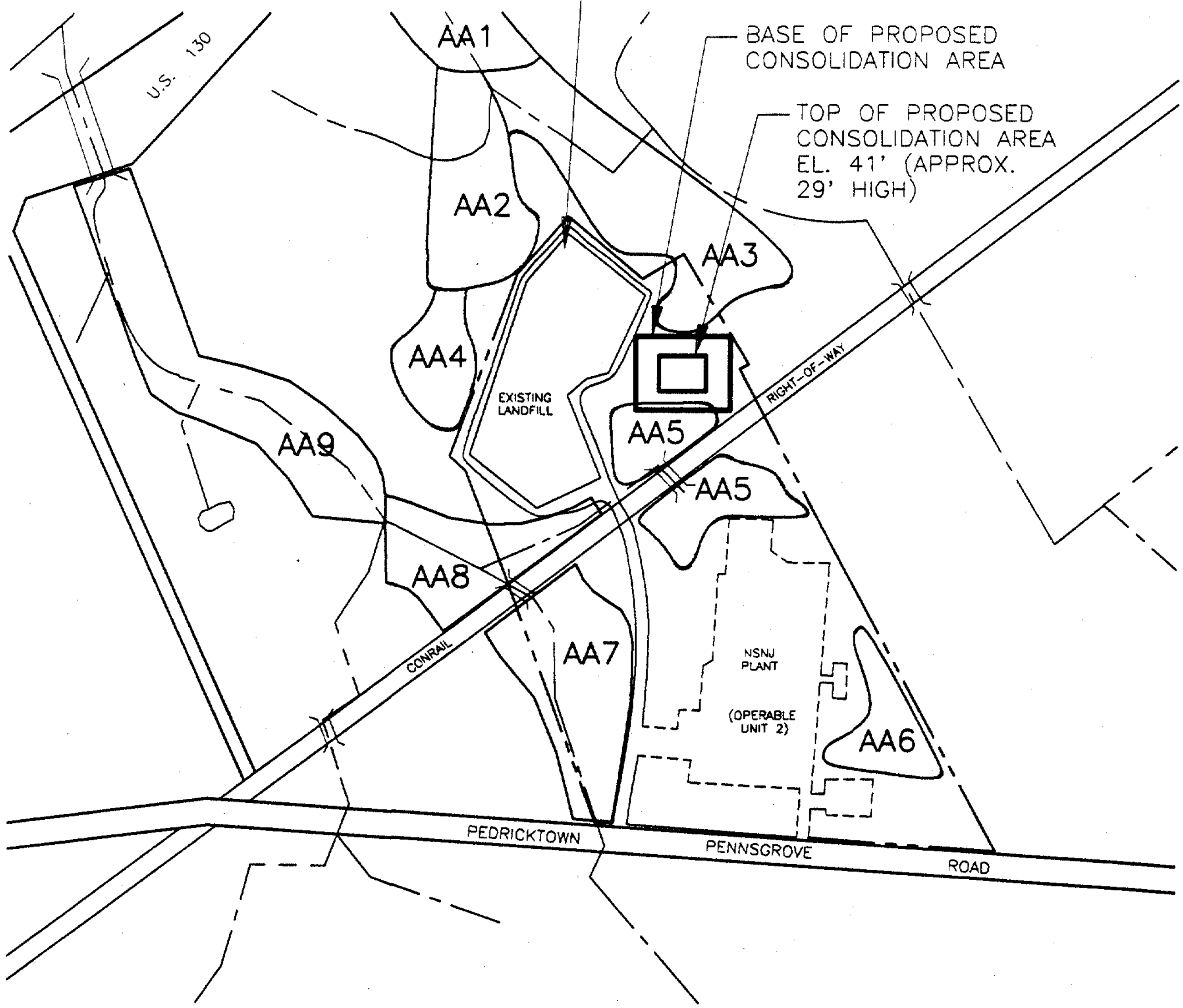
AA2 WETLANDS AREA

PLANT AREA

STREAM

PROPERTY LINE (APPROX.)

EXISTING CULVERT



(1) BASED ON MAXIMUM OBSERVED CONCENTRATION AT SOIL SAMPLE LOCATION.

600 0 600 1200

1" =600'

O'BRIEN & GERE ENGINEERS INC.
Edison, New Jersey

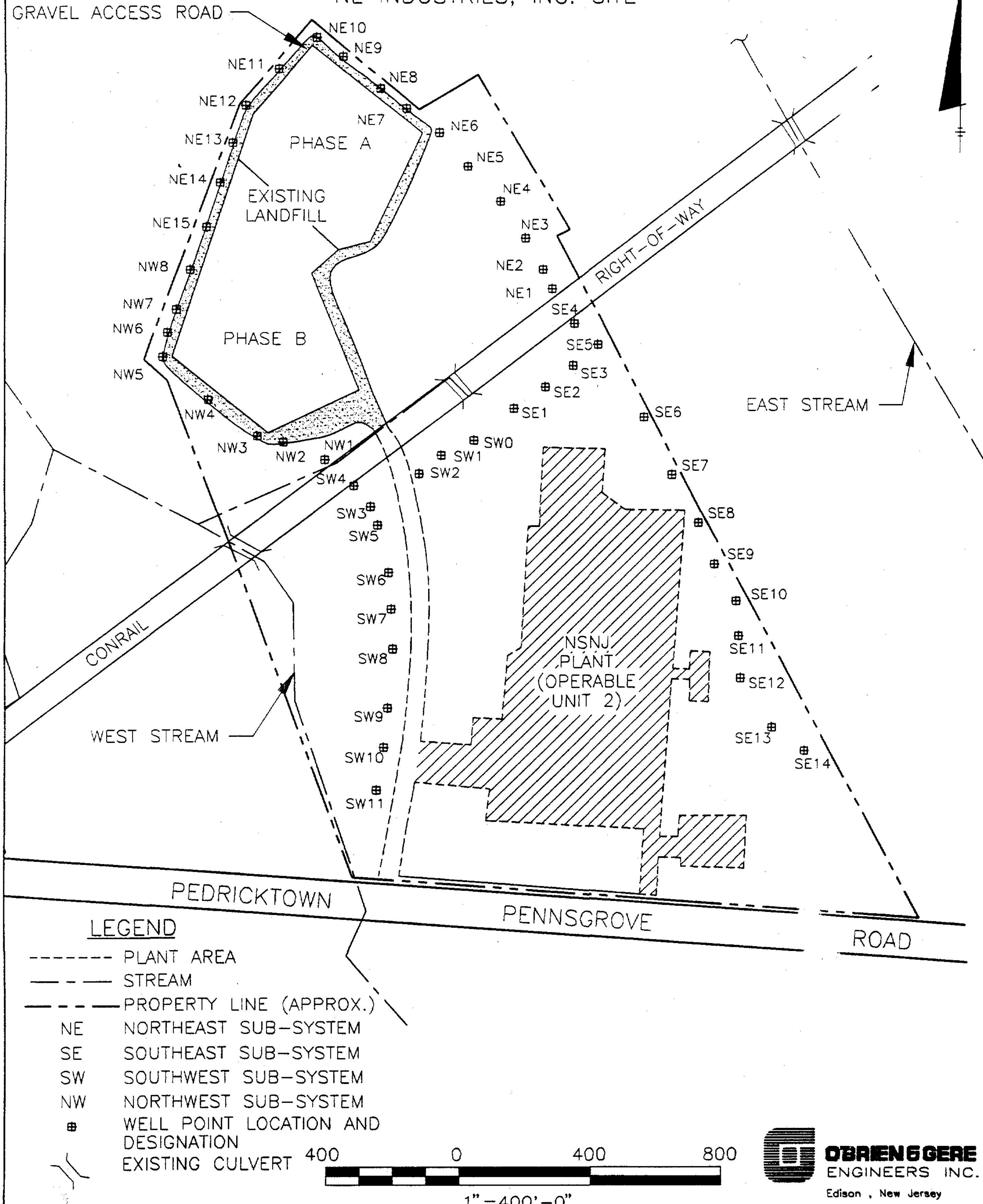
NLI 002 0848

284422-9600

EXISTING WELL POINT LOCATIONS

FIGURE 29

NL INDUSTRIES, INC. SITE

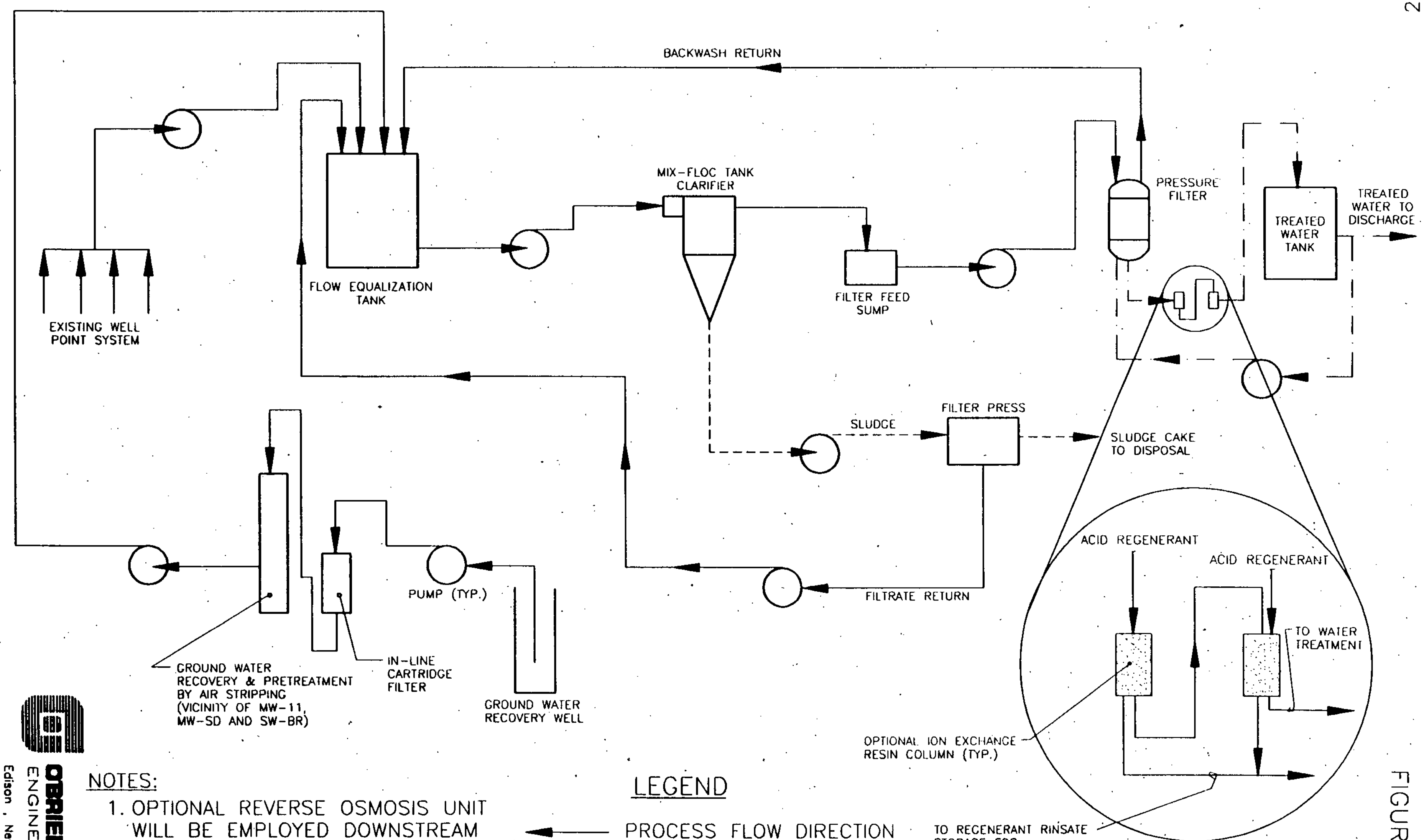


NLI 002 0849

GROUND WATER TREATMENT SYSTEM PROCESS SCHEMATIC

NL INDUSTRIES, INC. SITE

284434-9600



O'BRIEN & GERE ENGINEERS INC.
Edison, New Jersey

NOTES:

1. OPTIONAL REVERSE OSMOSIS UNIT WILL BE EMPLOYED DOWNSTREAM OF ION EXCHANGE UNITS, IF NECESSARY, BASED ON TREATMENT PLANT EFFLUENT DISCHARGE LIMITS AND LOCATION.

LEGEND

PROCESS FLOW DIRECTION
SLUDGE
TREATED WATER

NOT TO SCALE

FIGURE 30

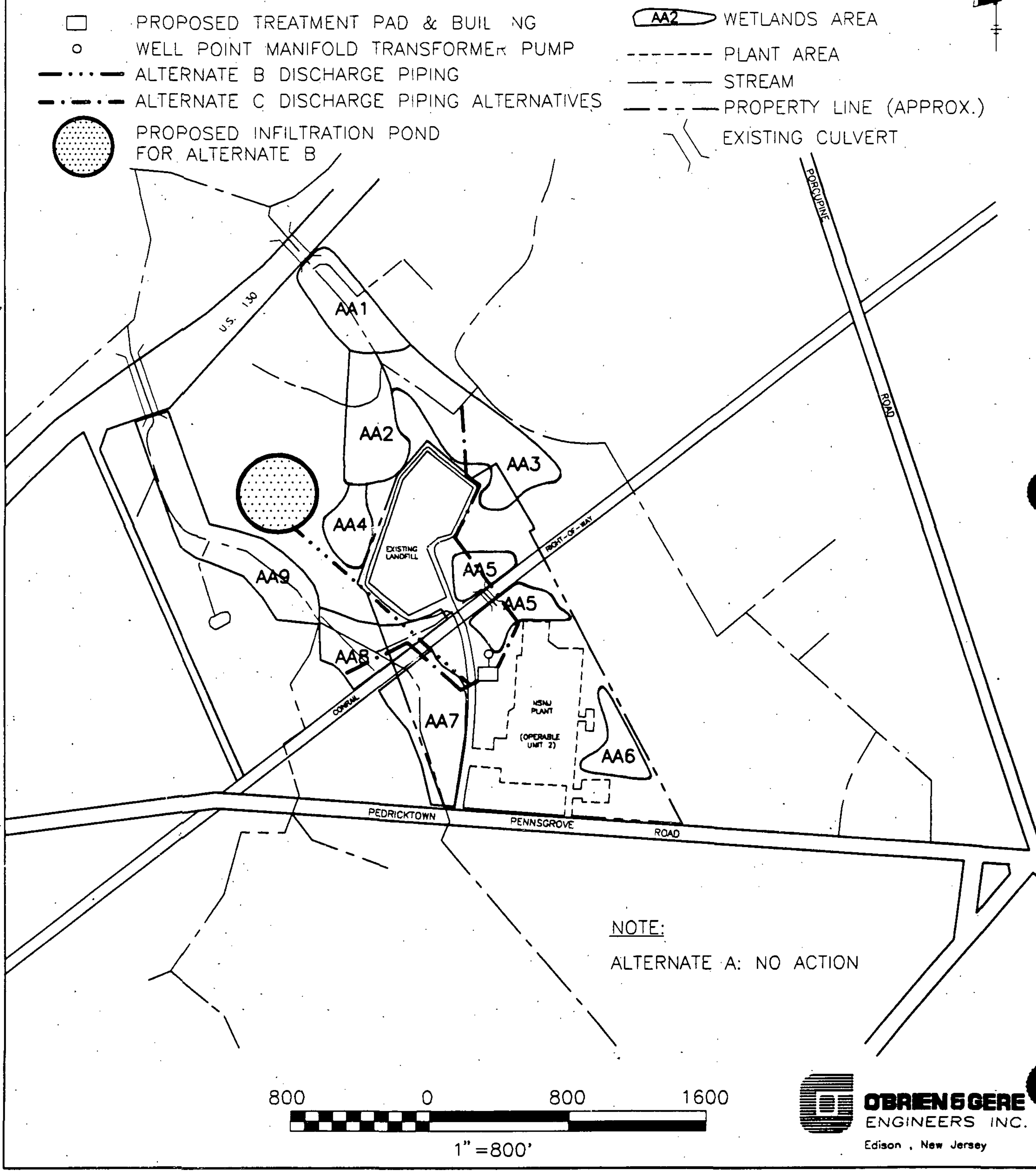
NL1 002 0850

28411-9600

FIGURE 31

TREATED WATER DISCHARGE ALTERNATES

NL INDUSTRIES, INC. SITE



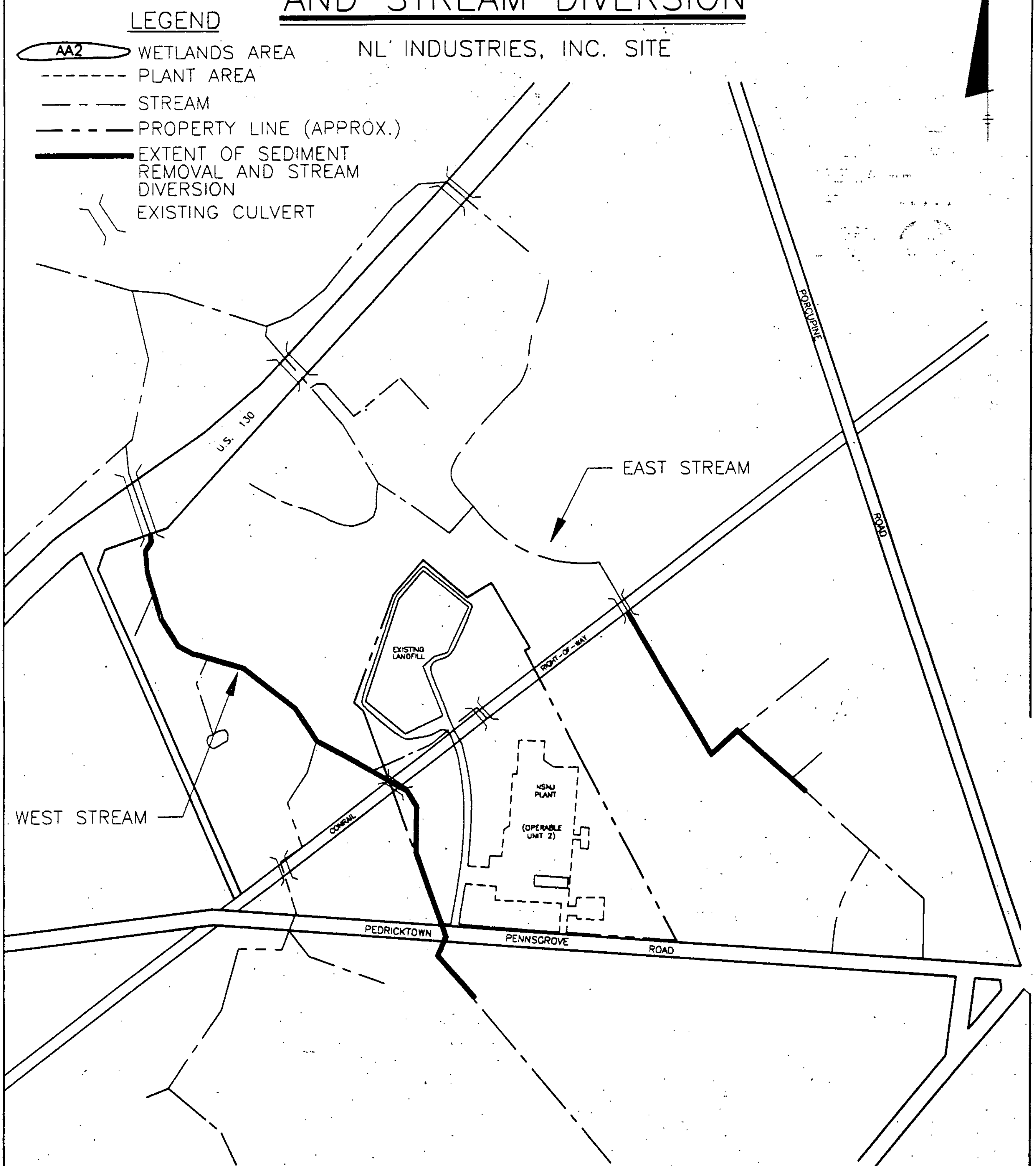
NLI 002 0851

28444-9600

EXTENT OF SEDIMENT REMOVAL AND STREAM DIVERSION

FIGURE 32

NL INDUSTRIES, INC. SITE



800 0 800 1600

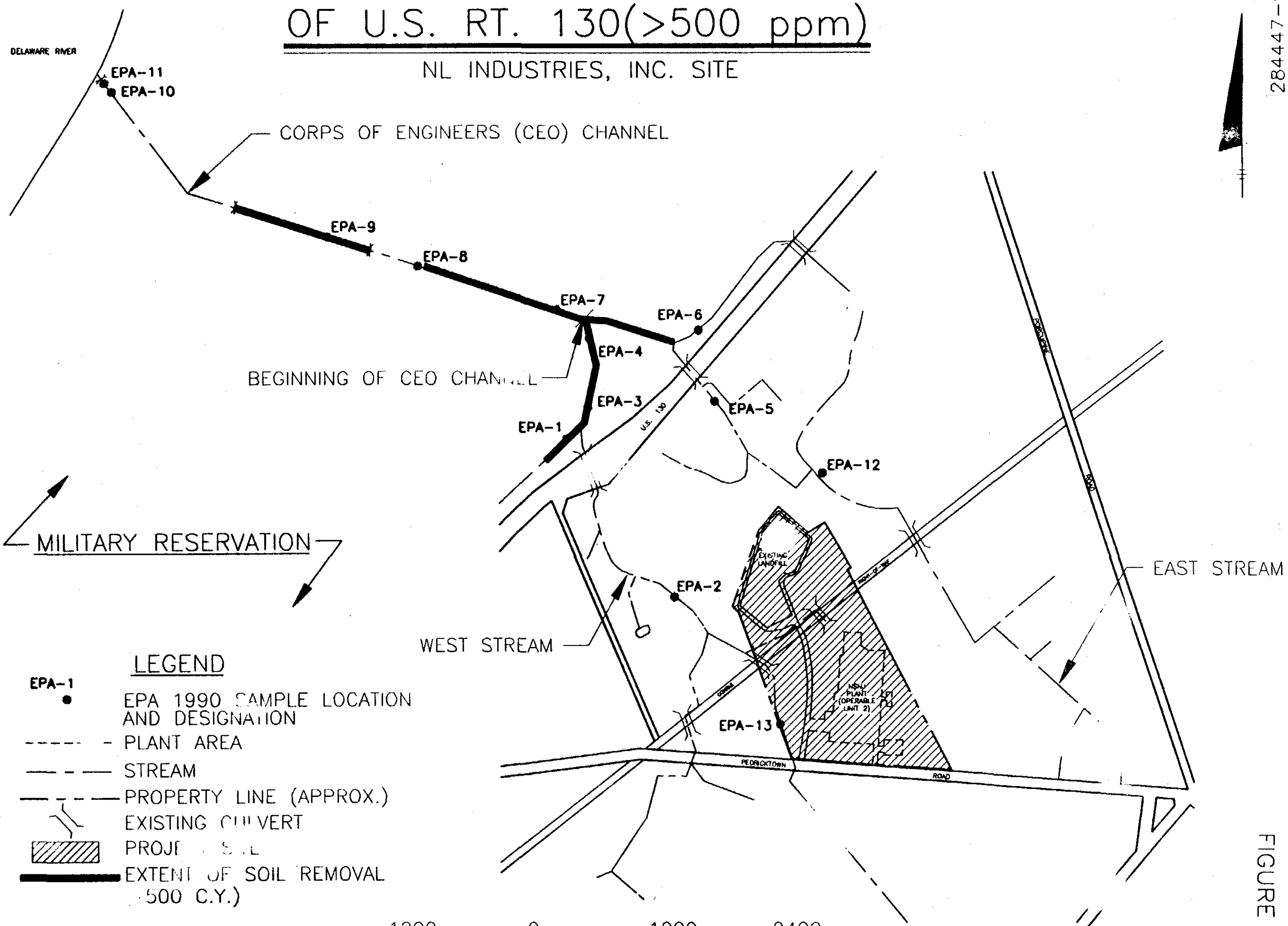
1"=800'

O'BRIEN & GERE ENGINEERS INC.
Edison, New Jersey

NLI 002 0852

EXTENT OF SEDIMENT REMOVAL NORTH OF U.S. RT. 130(>500 ppm)

NL INDUSTRIES, INC. SITE



284447-9600

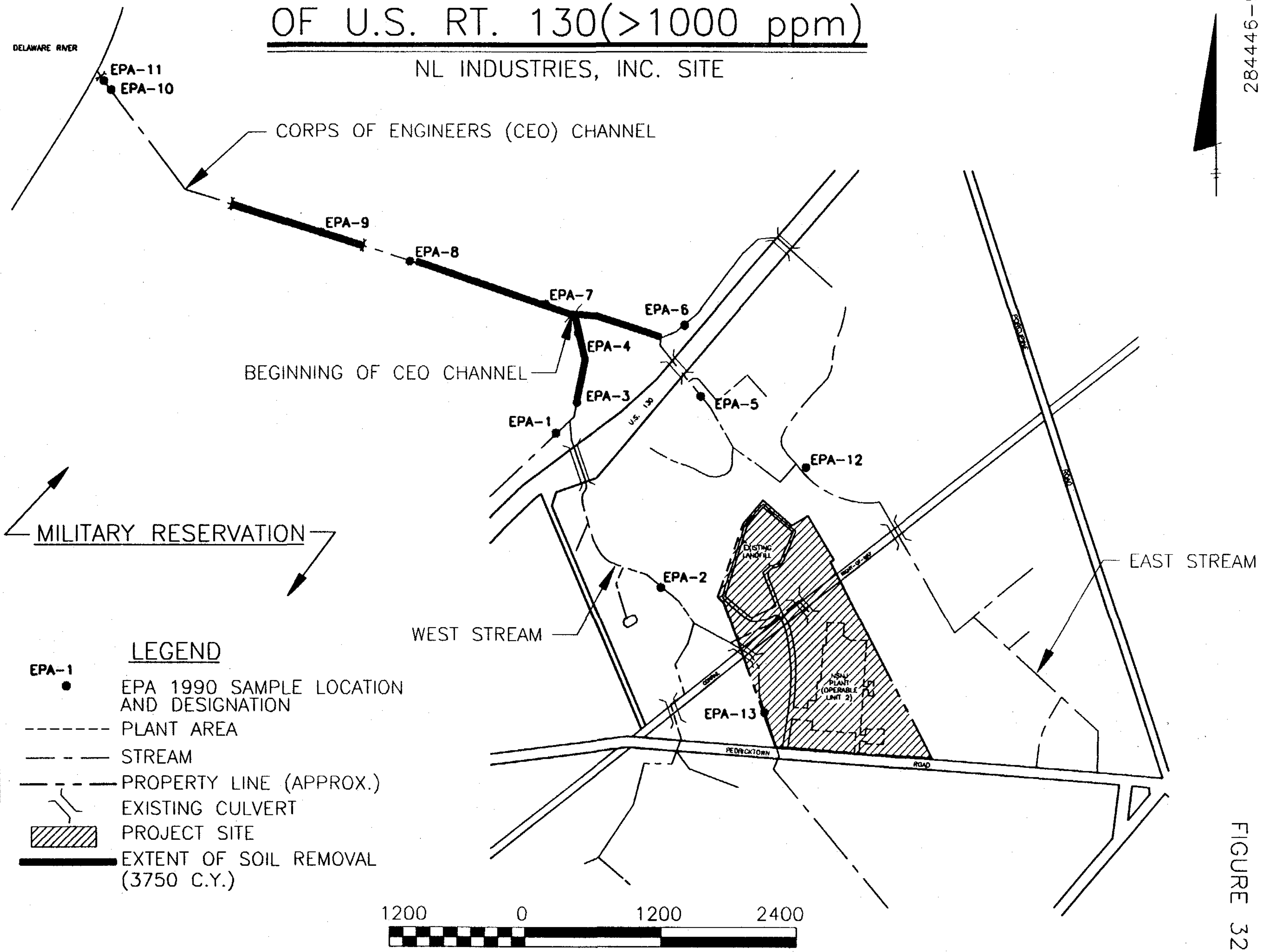
FIGURE 32

O'BRIEN & GERE ENGINEERS INC.
Edison, New Jersey

NL 002 0853

EXTENT OF SEDIMENT REMOVAL NORTH OF U.S. RT. 130(>1000 ppm)

NL INDUSTRIES, INC. SITE



O'BRIEN & GERE ENGINEERS INC.
Edison, New Jersey

284446-9600

FIGURE 32.2

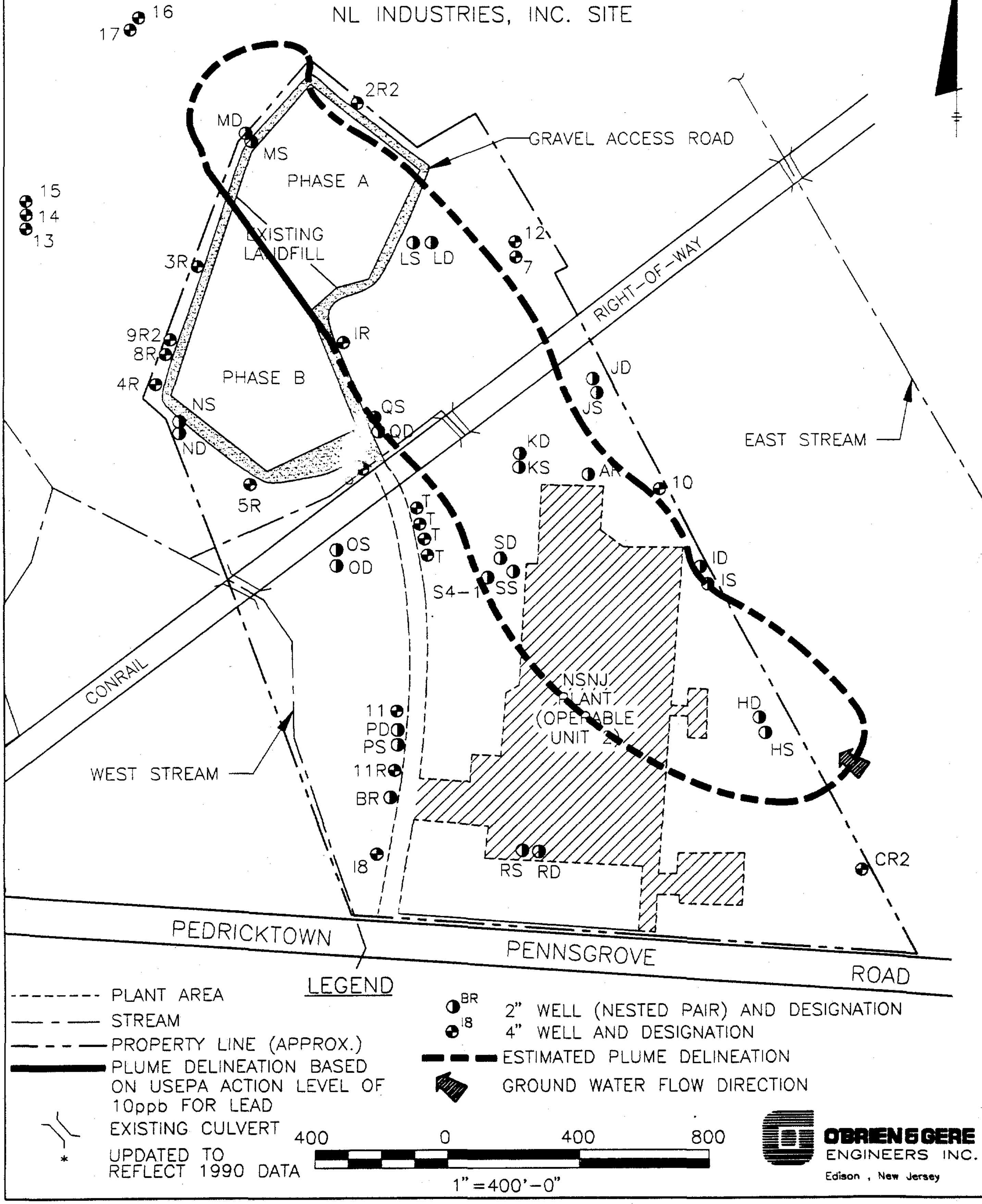
NL I 002 0854

284423-9600

FIGURE 33

UNCONFINED AQUIFER SHALLOW ZONE GROUND WATER QUALITY 1989* FOR LEAD

NL INDUSTRIES, INC. SITE



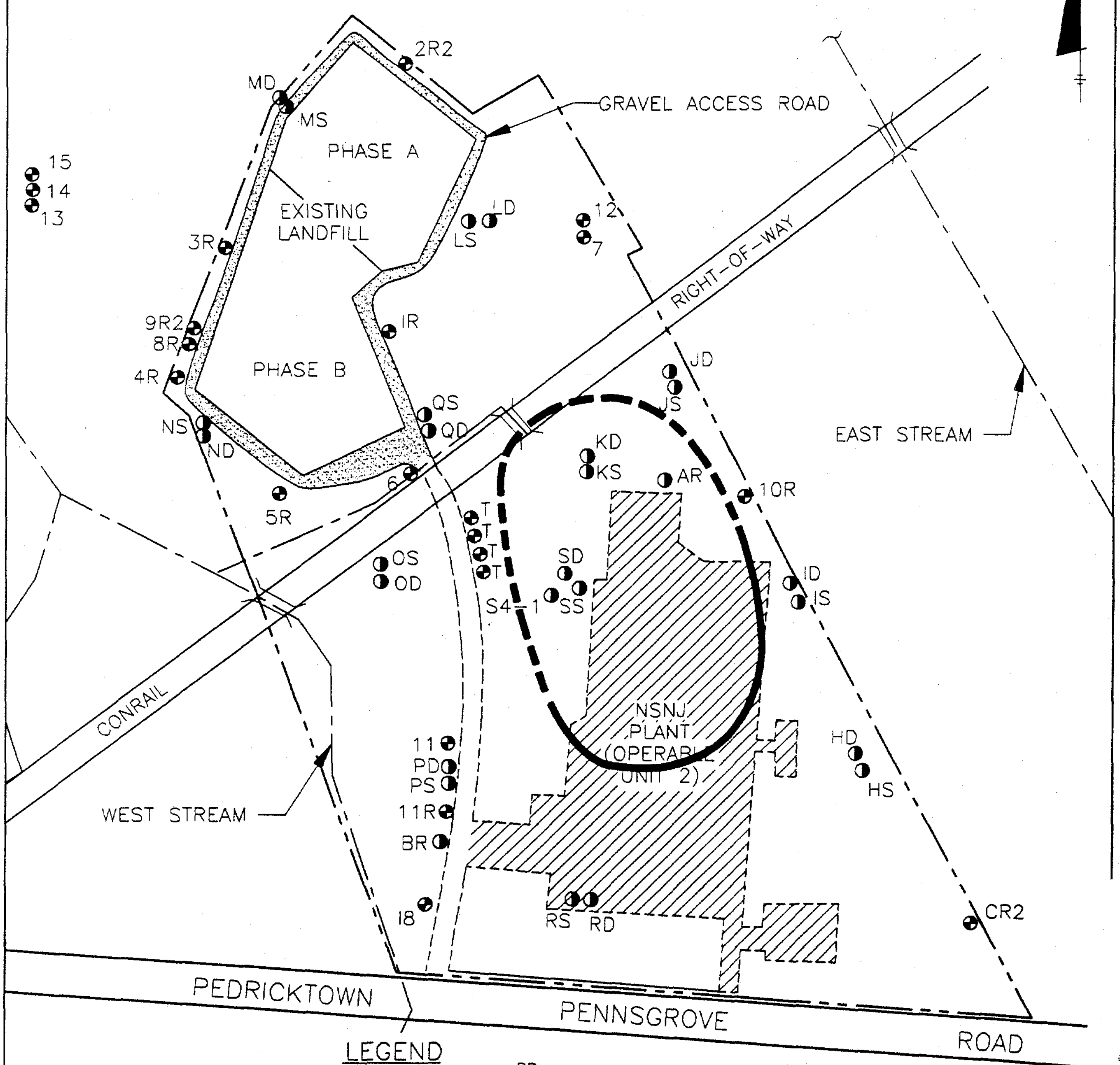
NLI 002 0855

2844249600

FIGURE 34

UNCONFINED AQUIFER SHALLOW ZONE GROUND WATER QUALITY 1989 FOR CADMIUM

NL INDUSTRIES, INC. SITE



LEGEND

- PLANT AREA
- STREAM
- PROPERTY LINE (APPROX.)
- PLUME DELINEATION BASED ON USEPA MCL OF 10 ppb AS OF JAN. 1990.
- EXISTING CULVERT
- BR 2" WELL (NESTED PAIR) AND DESIGNATION
- 18 4" WELL AND DESIGNATION
- ESTIMATED PLUME DELINEATION

400 0 400 800

1"=400'-0"

O'BRIEN & GERE ENGINEERS INC.
Edison, New Jersey

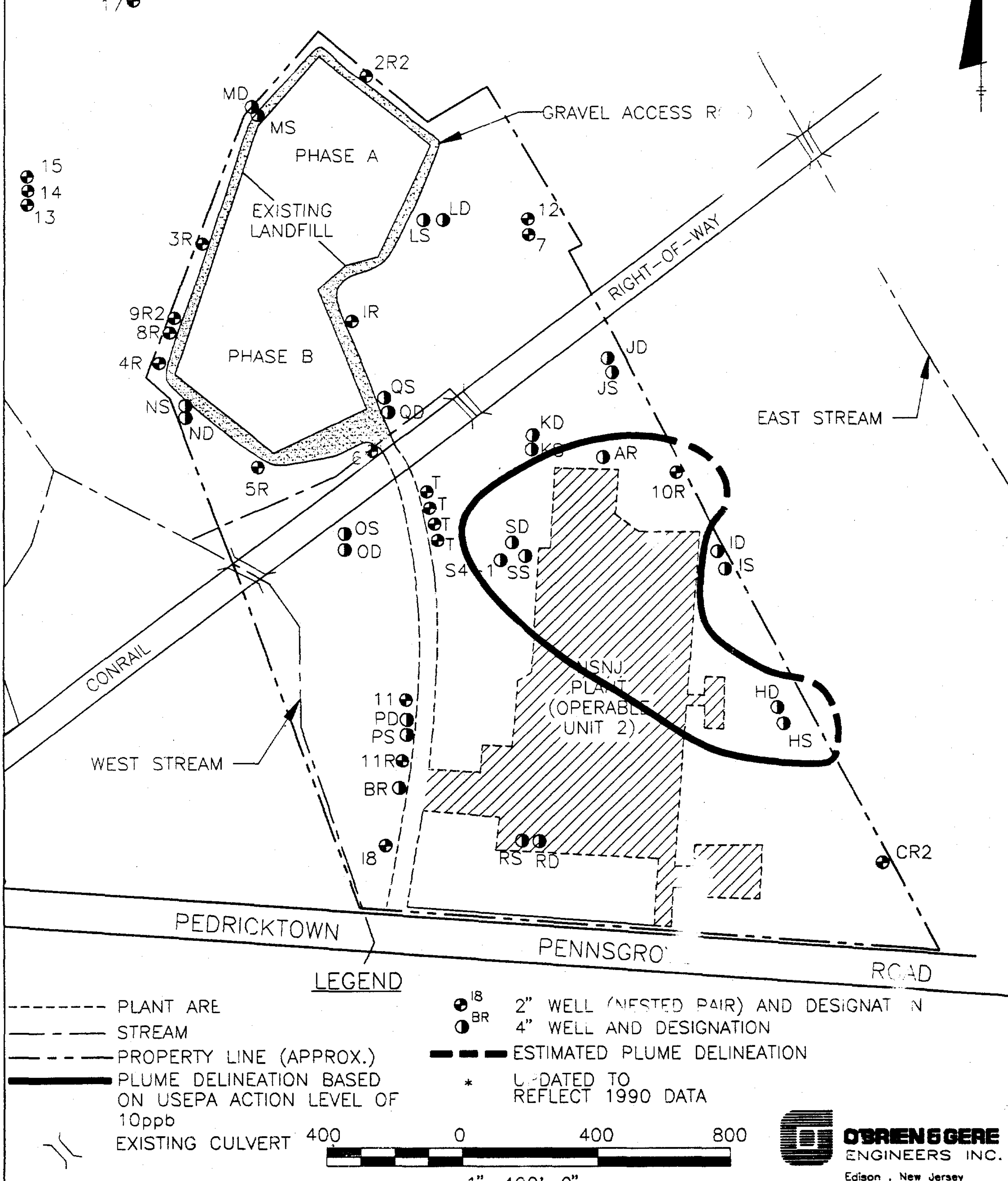
NL I 002 0856

284425-9600

FIGURE 35

UNCONFINED AQUIFER DEEP ZONE
GROUND WATER QUALITY 1989* FOR LEAD

NL INDUSTRIES, INC. SITE



O'BRIEN & GERE ENGINEERS INC.
Edison, New Jersey

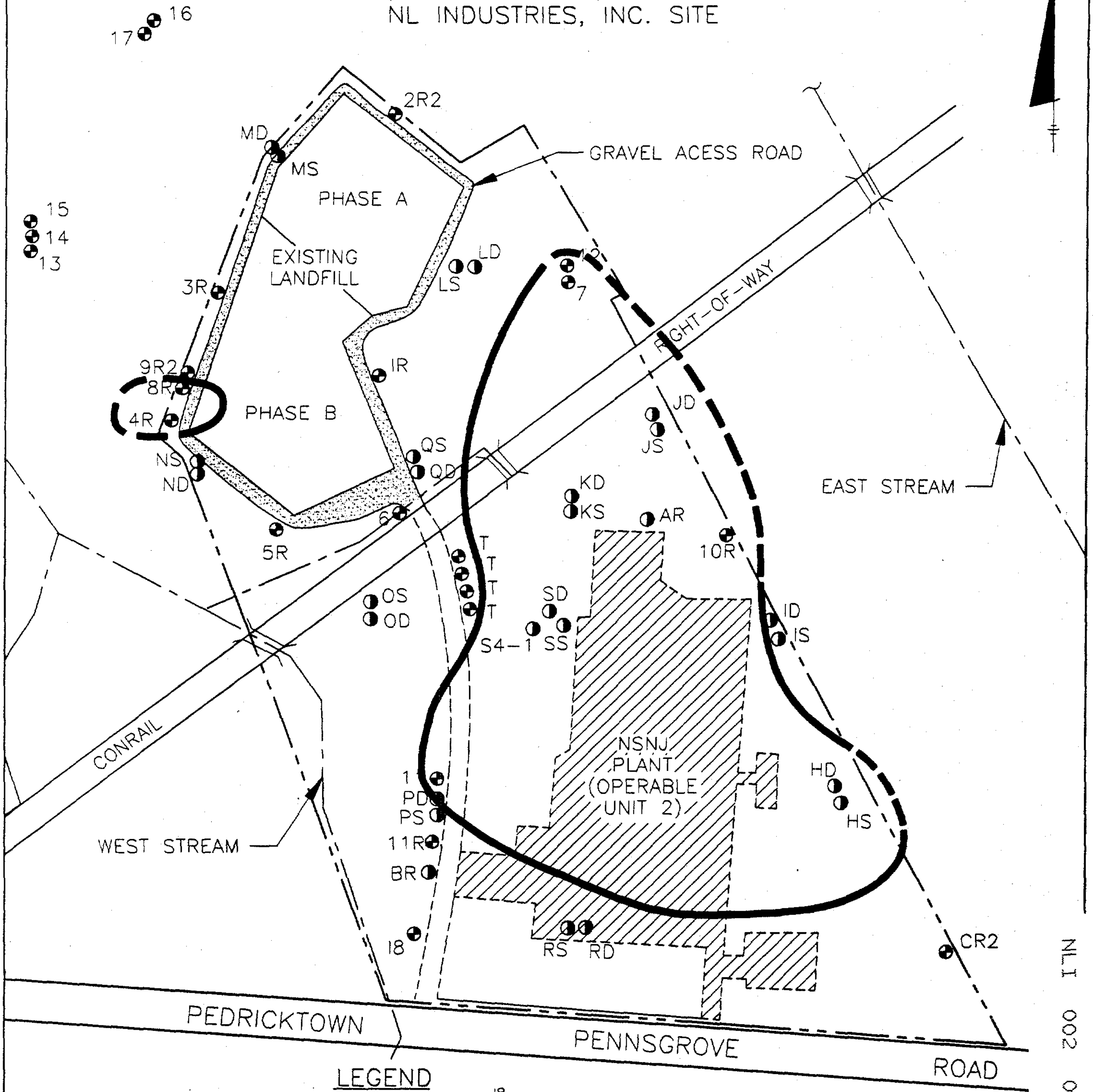
NLI 002 0857

284426-9600

FIGURE 36

UNCONFINED AQUIFER DEEP ZONE GROUND WATER QUALITY 1989 FOR CADMIUM

NL INDUSTRIES, INC. SITE



LEGEND

- PLANT AREA
- STREAM
- PROPERTY LINE (APPROX.)
- PLUME DELINEATION BASED ON USEPA MCL 10 ppb AS OF JAN. 1990
- EXISTING CULVERT
- 18 — 2" WELL (NESTED PAIR) AND DESIGNATION
- BR — 4" WELL AND DESIGNATION
- ESTIMATED PLUME DELINEATION

400 0 400 800

1"=400'-0"

O'BRIEN & GERE ENGINEERS INC.
Edison, New Jersey

NLI 002 0858

APPENDIX A

USEPA PHASE III ANALYTICAL RESULTS

Note: Related data obtained by O'Brien & Gere Engineers inserted by hand.

APPENDIX A

USEPA PHASE III ANALYTICAL RESULTS

Note: Related data obtained by O'Brien & Gere inserted by hand.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION II
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10278

JUN 7 1991

RECEIVED

JUN 10 1991

CORPORATE ENVIRONMENTAL SERVICES

Mr. Stephen W. Holt
NL Industries, Inc.
Corporate Environmental Services
P.O. Box 1090
Hightstown, N.J. 08520

Re: NL Industries Superfund Site - Phase III Oversight Sampling

Dear Mr. Holt:

Attached are the results of the Phase III oversight samples taken by EBASCO, EPA's oversight contractor at the NL Industries Superfund Site, which is located in Pedricktown, Salem County, New Jersey. Please note that the locations referred to in the Sediment Analysis package may be found in Figure V-1 in Volume IV of the Remedial Investigation for the site, dated March, 1991.

If you have any further questions, please call me at (212) 264-6418.

Sincerely yours,

Michael H. Gilbert

Michael H. Gilbert, Project Manager
Southern New Jersey Section II

Attachment

RECEIVED

JUN 1 1991

O'Brien & Gere Engineers, Inc.
Virginia Beach, VA

NLI 002 0861

NL INDUSTRIES
SEDIMENT ANALYSES
PHASE III NOV, DEC, 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS					
	EBAS	OBG	EBAS	OBG	EBAS	OBG
Organics (ug/kg)	NL-SD-EPA-02-01		NL-SD-EPA-02-02		NL-SD-FB-005	
	EPA-02		EPA-02		Field blank	
Depth	0 - 6 inches		6 - 12 inches			
Volatiles						
Chloromethane	14 U		13 U		10 U	
Bromomethane	14 U		13 U		10 U	
Vinyl Chloride	14 U		13 U		10 U	
Chloroethane	14 U		13 U		10 U	
Methylene Chloride	46 UJ		34 UJ		4 BJ	
Acetone	67 UJ		30 UJ		10 UJ	
Carbon Disulfide	7 U		6 U		5 U	
1,1-Dichloroethene	7 U		6 U		5 U	
1,1-Dichloroethane	7 U		6 U		5 U	
1,2-Dichloroethene (total)	7 U		6 U		5 U	
Chloroform	7 U		6 U		5 U	
1,2-Dichloroethane	7 U		6 U		18 J	
2-Butanone	14 U		13 R		10 U	
1,1,1-Trichloroethane	7 U		6 U		5 U	
Carbon Tetrachloride	7 U		6 U		5 U	
Vinyl Acetate	14 U		13 U		10 U	
Bromodichloromethane	7 U		6 U		5 U	
1,2,-Dichloropropane	7 U		6 U		5 U	
cis-1,3-Dichloropropene	7 U		6 U		5 U	
Trichloroethene	7 U		6 U		5 U	
Dibromochloromethane	7 U		6 U		5 U	
1,1,2-Trichloroethane	7 U		6 U		5 U	
Benzene	7 U		6 U		5 U	
trans-1,3-Dichloropropene	7 U		6 U		5 U	
Bromoform	7 U		6 U		5 U	
4-Methyl-2-Pentanone	14 U		13 U		10 U	
2-Hexanone	14 U		13 U		10 U	
Tetrachloroethene	7 U		6 U		5 U	
1,1,2,2-Tetrachloroethane	7 U		6 U		5 U	
Toluene	12		6 U		5 U	
Chlorobenzene	7 U		6 U		5 U	
Ethylbenzene	7 U		6 U		5 U	
Styrene	7 U		6 U		5 U	
Xylene (total)	7 U		6 U		5 U	

NL INDUSTRIES
SEDIMENT ANALYSES
PHASE III NOV, DEC, 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS					
	EBAS	OBG	EBAS	OBG	EBAS	OBG
Organics (ug/kg)	NL-SD-EPA-02-01		NL-SD-EPA-02-02		NL-SD-FB-005	
	EPA-02		EPA-02		Field blank	
Depth	0 - 6 inches		6 - 12 inches			
Volatiles Continued:						
Tentatively identified compounds (TICS)						
Total TICs	1		1			
Total TIC Concentration	33 JN		34 JN			

Qualifiers: J - estimated, U - nondetect, N - presumptive evidence of a compound; B - found in method blank; - R - rejected

NLI 002 0863

NL INDUSTRIES
SEDIMENT ANALYSES
PHASE III NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS					
	EBAS	OBG	EBAS	OBG	EBAS	OBG
Organics (ug/kg)	NL-SD-EPA-02-01		NL-SD-EPA-02-02		NL-SD-FB-005	
	EPA-02		EPA-02		Field Blank	
Depth	0 - 6 inches		6 -12 inches			
Base/Neutrals/Acids						
Phenol	450 UJ		420 UJ		10 U	
bis(2-Chloroethyl) ether	450 UJ		420 UJ		10 U	
2-Chlorophenol	450 UJ		420 UJ		10 U	
1,3-Dichlorobenzene	450 UJ		420 UJ		10 U	
1,4-Dichlorobenzene	450 UJ		420 UJ		10 U	
Benzyl alcohol	450 UJ		420 UJ		10 U	
1,2-Dichlorobenzene	450 UJ		420 UJ		10 U	
2-Methylphenol	450 UJ		420 UJ		10 U	
bis-(2-Chloroisopropyl)ether	450 UJ		420 UJ		10 U	
4-Methyphenol	450 UJ		420 UJ		10 U	
N-Nitroso-di-n-propylamine	450 UJ		420 UJ		10 U	
Hexachloroethane	450 UJ		420 UJ		10 U	
Nitrobenzene	450 UJ		420 UJ		10 U	
Isophorone	450 UJ		420 UJ		10 U	
2-Nitrophenol	450 UJ		420 UJ		10 U	
2,4-Dimethylphenol	450 UJ		420 UJ		10 U	
Benzoic acid	2200 UJ		2000 UJ		50 U	
bis(2-Chloroethoxy)methane	450 UJ		420 UJ		10 U	
2,4-Dichlorophenol	450 UJ		420 UJ		10 U	
1,2,4-Trichlorobenzene	450 UJ		420 UJ		10 U	
Naphthalene	450 UJ		420 UJ		10 U	
4-Chloroaniline	450 UJ		420 UJ		10 U	
Hexachlorobutadiene	450 UJ		420 UJ		10 U	
4-Chloro-3-methylphenol	450 UJ		420 UJ		10 U	
2-Methylnaphthalene	450 UJ		420 UJ		10 U	
Hexachlorocyclopentadiene	450 UJ		420 UJ		10 U	
2,4,6-Trichlorophenol	450 UJ		420 UJ		10 U	
2,4,5-Trichlorophenol	2200 UJ		2000 UJ		50 U	
2-Chloronaphthalene	450 UJ		420 UJ		10 U	
2-Nitroaniline	2200 UJ		2000 UJ		50 U	
Dimethylphthalate	450 UJ		420 UJ		10 U	
Acenaphylene	450 UJ		420 UJ		10 U	
2,6-Dinitrotoluene	450 UJ		420 UJ		10 U	
3-Nitroaniline	2200 UJ		2000 UJ		50 U	

NL INDUSTRIES
SEDIMENT ANALYSES
PHASE III NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

Organics (ug/kg)	LOCATIONS EBAS NL-SD-EPA-02-01 EPA -02	OBG	EBAS NL-SD-EPA-02-02 EPA- 02	OBG	EBAS NL-SD-FB-005 Field Blank	OBG
Depth	0 -6 inches		6 - 12 inches			
Base/Neutrals/Acids Continued:						
Acenaphthene	450 UJ		420 UJ		10 U	
2,4-Dinitrophenol	2200 UJ		2000 UJ		50 U	
4-Nitrophenol	2200 UJ		2000 UJ		50 U	
Dibenzofuran	450 UJ		420 UJ		10 U	
2,4-Dinitrotoluene	450 UJ		420 UJ		10 U	
Diethylphthalate	450 UJ		420 UJ		10 U	
4-Chlorophenyl-phenylether	450 UJ		420 UJ		10 U	
Fluorene	450 UJ		420 UJ		10 U	
4-Nitroaniline	2200 UJ		2000 UJ		50 U	
4,6-Dinitro-2-methylphenol	2200 UJ		2000 UJ		50 U	
N-Nitrosodiphenylamine (1)	450 UJ		420 UJ		10 U	
4-Bromophenyl-phenylether	450 UJ		420 UJ		10 U	
Hexachlorobenzene	450 UJ		420 UJ		10 U	
Pentachlorophenol	2200 UJ		2000 UJ		50 U	
Phenanthrene	450 UJ		420 UJ		10 U	
Anthracene	450 UJ		420 UJ		10 U	
Di-n-butylphthalate	450 UJ		420 UJ		10 U	
Fluoranthene	450 UJ		420 UJ		10 U	
Pyrene	450 UJ		420 UJ		10 U	
Butylbenzylphthalate	450 UJ		420 UJ		10 U	
3,3'-dichlorobenzidine	900 UJ		840 UJ		20 U	
Benzo(a)anthracene	450 UJ		420 UJ		10 U	
Chrysene	450 UJ		420 UJ		10 U	
bis(2-Ethyhexyl)phthalate	450 UJ		420 UJ		8 BJ	
Di-n-octylphalate	450 UJ		420 UJ		10 U	
Benzo(b)fluoranthene	450 UJ		420 UJ		10 U	
Benzo(k)fluoranthene	450 UJ		420 UJ		10 U	
Benzo(a)pyrene	450 UJ		420 UJ		10 U	
Indeno(1,2,3-cd)pyrene	450 UJ		420 UJ		10 U	
Dibenz(a,h)anthracene	450 UJ		420 UJ		10 U	
Benzo(g,h,i)perylene	450 UJ		420 UJ		10 U	

NL INDUSTRIES
SEDIMENT ANALYSES
PHASE III NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS			
	EBAS	OBG	EBAS	OBG
Organics (ug/kg)	NL-SD-EPA-02-01 EPA-02		NL-SD-FB-005 Field Blank	
Depth	0 - 6 inches			
Pesticides/PCBs				
alpha-BHC	NA		0.050 U	
beta-BHC	NA		0.050 U	
delta-BHC	NA		0.050 U	
gamma-BHC (Lindane)	NA		0.050 U	
Heptachlor	NA		0.050 U	
Aldrin	NA		0.050 U	
Heptachlor epoxide	NA		0.050 U	
Endosulfan I	NA		0.050 U	
Dieldrin	NA		0.10 U	
4,4'-DDE	NA		0.10 U	
Endrin	NA		0.10 U	
Endosulfan II	NA		0.10 U	
4,4'-DDD	NA		0.10 U	
Endosulfan sulfate	NA		0.10 U	
4,4'-DDT	NA		0.10 U	
Methoxychlor	NA		0.50 U	
Endrin ketone	NA		0.10 U	
alpha-Chlordane	NA		0.50 U	
gamma-Chlordane	NA		0.50 U	
Toxaphene	NA		1.00 U	
Aroclor-1016	NA		0.50 U	
Aroclor-1221	NA		0.50 U	
Aroclor-1232	NA		0.50 U	
Aroclor-1242	NA		0.50 U	
Aroclor-1248	NA		0.50 U	
Aroclor-1254	NA		1.00 U	
Aroclor-1260	NA		1.00 U	

Qualifiers: U - nondetect; NA - not analyzed

NL INDUSTRIES
SEDIMENT ANALYSES
PHASE III NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS					
	EBAS	OBG	EBAS	OBG	EBAS	OBG
Organics (ug/kg)	NL-SD-EPA-02-01 EPA -02		NL-SD-EPA-02-02 EPA- 02		NL-SD-FB-005 Field Blank	
Depth	0 -6 inches		6 - 12 inches			
Base/Neutrals/Acids Continued:						
Tentatively identified compounds (TICS)						
Total TICs	19		18		1	
Total TIC Concentration	31270.00 JN		16030 JN		5.4 JN	

Qualifiers: J - estimated, U - nondetect; N - presuntive evidence of a compound; B - found in method blank

NL INDUSTRIES
SEDIMENT ANALYSES
PHASE III NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS	
	EBAS	OBG
Inorganics(ug/l)	NL-SD-EPA-02-01	
	EPA-02	
Depth	0 - 6 inches	
TCLP Inorganics		
Arsenic	6.38	
Barium	70.20	
Beryllium	5.00 U	
Cadmium	5.00 U	
Chromium	7.00 U	
Lead	134.00	
Mercury	0.20 U	
Selenium	30.00 UJ	
Silver	9.00 UJ	

Qualifiers: J - estimated; U - nondetect

NLI 002 0868

NL INDUSTRIES
SEDIMENT ANALYSES
PHASE III NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS								
	EBAS		OBG	EBAS		OBG	EBAS		OBG
Inorganics (mg/kg)	NL-SD-EPA-03-03			NL-SD-EPA-04-02			NL-SD-EPA-04-03		
	EPA-03			EPA-04			EPA-04		
Depth	12 - 18 inches			6- 12 inches			12 - 18 inches		
Trace Metals									
Antimony	7.90	R		7.00	R		5.70	R	
Arsenic	8.20	J		7.9			4.80	J	
Cadmium	0.75	R		0.66	R		0.49	J	
Chromium	46.60	J		31.10	J		6.50	J	
Copper	26.80	J		5.9			1.90	J	
Lead	112.00	J		34.50	J		14.70	J	
Selenium	0.65			0.23			0.13	J	
Zinc	39.30	J		25.60	J		9.50	J	

Qualifiers: J - estimatet; R - rejected

NLI 002 0869

NL INDUSTRIES
SEDIMENT ANALYSES
PHASE III NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS								
	EBAS		OBG	EBAS		OBG	EBAS		OBG
Inorganics (mg/kg)	NL-SD-EPA-05-01			NL-SD-EPA-05-02			NL-SD-EPA-06-01		
	EPA-05			EPA-05			EPA-06		
Depth	0 - 6 inches			6- 12 inches			0 - 6 inches		
Trace Metals									
Antimony	28.90	R		47.30	R		9.80	R	
Arsenic	2.60	J		12.00	J		6.00	R	
Cadmium	6.00	R		4.01	R		2.50	R	
Chromium	277.00	J		229			82.9		
Copper	182.00	J		143			55		
Lead	395.00	J		375			117.00	J	
Selenium	3.10	J		3.60	J		2.00	J	
Zinc	1.87	J		600			367.00	J	
TOC	NA			NA			26006		

Qualifiers: J - estimated; R - rejected; NA - not analyzed

NL INDUSTRIES
SEDIMENT ANALYSES
PHASE III NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS								
	EBAS		OBG	EBAS		OBG	EBAS		OBG
Inorganics (mg/kg)	NL-SD-EPA-06-02			NL-SD-EPA-06-03			NL-SD-EPA-07-01		
	EPA - 06			EPA - 06			EPA-07		
Depth	6 - 12 inches			12 - 18 inches			0 - 6 inches		
Trace Metals									
Antimony	12.40	R		12.00	R		44.00	R	
Arsenic	48.80	J		39.40	J		20.30	J	
Cadmium	11.60	J		6.30	R		33.70	J	
Chromium	103.00	J		74.70	J		204.00	J	
Copper	82.30	J		51.30	J		138.00	J	
Lead	206.00	J		111.00	J		1060.00	J	
Selenium	3.44	R		1.70	J		1.40	J	
Zinc	1120.00	J		590			1340.00	J	
TOC	34155.00	J		NA			122883.00	J	

Qualifiers: J - estimated; R - rejected; NA - not analyzed

NLI 002 0871

NL INDUSTRIES
SEDIMENT ANALYSES
PHASE III NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS								
	EBAS		OBG	EBAS		OBG	EBAS		OBG
Inorganics (mg/kg)	NL-SD-EPA-07-02			NL-SD-EPA-07-03			NL-SD-EPA-08-01		
	EPA - 07			EPA - 07			EPA-08		
Depth	6 - 12 inches			12 - 18 inches			0 - 6 inches		
Trace Metals									
Antimony	38.80	R		13.90	R		6.90	R	
Arsenic	30.00	J		19.60	J		9.00	J	
Cadmium	19.10	J		5.20	J		0.59	R	
Chromium	149.00	J		107.00	J		13.70	J	
Copper	114.00	J		19.80	J		6.10	J	
Lead	423.00	J		159.00	J		46.60	J	
Selenium	2.40	J		1.80	J		0.22	J	
Zinc	642.00	J		295.00	J		75.20	J	
TOC	27961.00	J		59868.00	J		3374		

Qualifiers: J - estimated; R - rejected

NL INDUSTRIES
SEDIMENT ANALYSES
PHASE III NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS								
	EBAS		OBG	EBAS		OBG	EBAS		OBG
Inorganics (mg/kg)	NL-SD-EPA-08-02			OBG-SD-EPA-08-0			NL-SD-EPA-09-01		
	EPA - 08			EPA - 08			EPA-09		
Depth	6 - 12 inches			Split of composite sample			0 - 6 inches		
Trace Metals									
Antimony	6.30	R		14.10	R		15.10	R	
Arsenic	6.50	J		16.90	J		50.80	J	
Cadmium	1.10	R		3.50	R		33.90	J	
Chromium	15.00	J		34.70	J		103.00	J	
Copper	7.80	J		20.40	J		82.80	J	
Lead	34.30	J		291.00	J		598.00	J	
Selenium	0.21	J		0.54	J		2.20	J	
Zinc	135.00	J		217.00	J		1430.00	J	
TOC	3568			16127			89119	J	

Qualifiers: J - estimated; R - rejected

NL INDUSTRIES
SEDIMENT ANALYSES
PHASE III NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS					
	EBAS	OBG	EBAS	OBG	EBAS	OBG
	NL-SD-EPA-9-02		NL-SD-EPA-10-01		NL-SD-EPA-10-2	
Inorganics (mg/kg)	EPA-9		EPA - 10		EPA - 10	
Depth	6 - 12 inches		0 - 6 inches		6 - 12 inches	
Trace Metals						
Antimony	24.50 R		8.60 R		8.00 R	
Arsenic	64.20 J		30.60 J		27.40 J	
Cadmium	31.80 J		1.20 R		1.10 R	
Chromium	107.00 J		23.20 J		52.20 J	
Copper	86.20 J		10.90 J		26.20 J	
Lead	668.00 J		38.60 J		60.10 J	
Selenium	2.50 J		0.20 J		0.33 J	
Zinc	1350.00 J		190.00 J		274.00 J	
TOC	NA		2749.60 J		15849.00 J	

Qualifiers: J - estimated; R - rejected; NA - not analyzed

NL INDUSTRIES
SEDIMENT ANALYSES
PHASE III NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS								
	EBAS		OBG	EBAS		OBG	EBAS		OBG
	NL-SD-EPA-11-01			NL-SD-EPA-12-01			NL-SD-EPA-12-02		
Inorganics (mg/kg)	EPA - 11			EPA - 12			EPA - 12		
Depth	0 - 6 inches			0 - 6 inches			6 - 12 inches		
Trace Metals									
Antimony	8.20	R		6.40	R		5.90	R	
Arsenic	21.70	J		0.96	J		1.00	J	
Cadmium	0.71	R		0.55	R		0.51	J	
Chromium	21.30	J		17.00	J		24.40	J	
Copper	12.10	J		21.20	J		1.60	J	
Lead	57.40	J		19.00	J		5.30	J	
Selenium	0.37	J		0.10	J		0.11	J	
Zinc	223.00	J		62.40	J		64.30	J	
TOC	16071			14809.00	J		1843.00	J	

Qualifiers: J - estimated; R - rejected

NL INDUSTRIES
SEDIMENT ANALYSES
PHASE III NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS						
	EBAS		OBG	EBAS		OBG	EBAS
	NL-SD-EPA-13-01			NL-SD-EPA-13-02			NL-SD-FB-007
Inorganics (mg/kg)	EPA - 13			EPA - 13			Field Blank
Depth	0 - 6 inches			6 - 12 inches			
Trace Metals							
Antimony	32.30	R		8.10	R		
Arsenic	52.00	J		1.00	J		
Cadmium	5.10	J	2	0.70	R		
Chromium	15.40	J		41.10	J		
Copper	24.50	J		3.20	J		
Lead	2470.00	J	8.27	33.50	J	1.31	
Selenium	1.10	J		0.46	J		
Zinc	83.40	J		26.10	J		
TOC	2368.00	J		113938.00	J		1.00 U

Qualifiers: U - nondetect; J - estimated

NL INDUSTRIES
SEDIMENT ANALYSES
PHASE III NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS								
	EBAS		OBG	EBAS		OBG	EBAS		OBG
	NL-SD-WS-9-01			NL-SD-WS-15-01			NL-SD-ES-14-01		
Inorganics (mg/kg)									
Depth	0 - 6 inches			0 - 6 inches			0 - 6 inches		
Trace Metals									
Antimony	6.80	R		NA			NA		
Arsenic	6.80	J		NA			NA		
Cadmium	1.60	J		NA			NA		
Chromium	10.00	J		NA			NA		
Copper	6.80	J		NA			NA		
Lead	19.00	J		928.00	J		513.00	J	
Selenium	0.21	J		NA			NA		
Zinc	51.00	J		NA			NA		

Qualifiers: U - nondetect; J - estimated; NA - not analyzed

NL INDUSTRIES
SEDIMENT ANALYSES
PHASE III NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS	
	EBAS	OBG
	NL-SD-ES-16-01	
Inorganics (mg/kg)		
Depth	0 - 6 inches	
Lead	311.00 J	

Qualifiers: J - estimated

NL INDUSTRIES
SEDIMENT ANALYSES
PHASE III NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS							
	EBAS	OBG	EBAS	OBG	EBAS	OBG	EBAS	OBG
Grain Size	NL-SD-EPA-03-03		NL-SD-EPA-04-02		NL-SD-EPA-04-03		NL-SD-EPA-05-01	
	EPA-03		EPA-04		EPA-04		EPA-05	
Depth	12 - 18 inches		6- 12 inches		12 - 18 inches		0 - 6 inches	
Sive #	**Cumulative %**		**Cumulative %**		**Cumulative %**		**Cumulative %**	
3/8"	0.00		0.00		0.00		0.00	
4	0.00		0.00		0.00		0.00	
10	1.00		0.00		0.30		0.00	
40	6.50		7.10		21.00		1.30	
80	16.60		23.00		69.90		4.80	
100	17.60		24.70		75.30		17.90	
140	20.00		28.20		84.20		20.20	
200	21.9		31.3		88.3		22.4	

NL INDUSTRIES
SEDIMENT ANALYSES
PHASE III NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS			
	EBAS OBG	EBAS OBG	EBAS OBG	EBAS OBG
Grain Size	NL-SD-EPA-06-01 EPA-06	NL-SD-EPA-06-02 EPA-06	NL-SD-EPA-06-03 EPA-06	NL-SD-EPA-07-02 EPA-07
Depth	0 - 6 inches	6- 12 inches	12 - 18 inches	6 - 12 inches
Sive #	**Cumulative %**	**Cumulative %**	**Cumulative %**	**Cumulative %**
3/8"	0.00	0.00	0.50	0.00
4	0.00	0.00	0.50	0.00
10	0.00	0.20	1.20	1.10
40	5.00	1.00	8.20	2.50
80	18.40	7.70	23.80	10.80
100	21.80	10.50	26.00	13.50
140	27.20	16.90	29.70	20.60
200	32.10	23.90	32.70	26.50

NL INDUSTRIES
SEDIMENT ANALYSES
PHASE III NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS			
	EBAS OBG	EBAS OBG	EBAS OBG	EBAS OBG
Grain Size	NL-SD-EPA-07-03	NL-SD-EPA-08-01	NL-SD-EPA-08-02	OBG-SD-EPA-08-01
	EPA - 07	EPA - 08	EPA-08	EPA - 08
Depth	12 - 18 inches	0 - 6 inches	6 - 12 inches	Split of composite sample
Sive #	**Cumulative %**	**Cumulative %**	**Cumulative %**	**Cumulative %**
3/8"	0.00	0.00	0.00	0.00
4	0.00	0.00	1.80	0.00
10	3.30	1.90	1.90	0.50
40	7.70	17.70	18.10	1.00
80	25.60	67.40	65.90	1.90
100	30.80	73.50	72.10	2.60
140	42.10	82.80	80.00	7.40
200	49.80	87.70	84.80	21.60

NL INDUSTRIES
SEDIMENT ANALYSES
PHASE III NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS							
	EBAS	OBG	EBAS	OBG	EBAS	OBG	EBAS	OBG
Grain Size	NL-SD-EPA-09-01		NL-SD-EPA-09-02		NL-SD-EPA-10-01		NL-SD-EPA-10-02	
	EPA - 09		EPA - 09		EPA-10		EPA-10	
Depth	0 - 6 inches		6 - 12 inches		0 - 6 inches		6 - 12 inches	
Sive #	**Cumulative %**		**Cumulative %**		**Cumulative %**		**Cumulative %**	
3/8"	0.00		0.00		2.80		0.00	
4	0.00		0.00		4.80		1.50	
10	0.50		0.30		6.20		3.50	
40	0.80		0.70		22.10		10.80	
80	2.10		1.60		64.50		44.80	
100	2.50		1.80		69.90		49.30	
140	3.00		2.40		78.30		56.60	
200	3.60		2.90		84.10		64.00	

NL INDUSTRIES
SEDIMENT ANALYSES
PHASE III NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS EBAS	OBG	EBAS	OBG	EBAS	OBG	EBAS	OBG
	NL-SD-EPA-11-01		NL-SD-EPA-12-01		NL-SD-EPA-12-02		NL-SD-EPA-13-01	
Grian Size	EPA - 11		EPA - 12		EPA - 12		EPA-13	
Depth	0 - 6 inches		0 - 6 inches		6 - 12 inches		0 -6 inches	
Sive #	**Cumulative %**		**Cumulative %**		**Cumulative %**		**Cumulative %**	
3/8"	0.00		0.50		0.00		0.00	
4	0.20		0.80		0.00		0.00	
10	0.80		2.90		1.90		1.30	
40	6.00		46.60		49.60		11.80	
80	41.80		92.90		92.70		46.10	
100	48.90		94.70		94.70		50.30	
140	64.40		96.50		97.10		58.10	
200	79.20		97.00		97.90		63.20	

NL INDUSTRIES
SOIL ANALYSES
PHASE III NOV, 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS						
	EBAS	OBG	EBAS	OBG	EBAS	OBG	EBAS
Inorganics (mg/kg)	NL-SO-63-0		NL-SO-63-3		NL-SO-63-6		NL-SO-63-12
Depth	0 - 3 inches		3 - 6 inches		6 - 12 inches		12 - 18 inches
Lead	709 J		974 J		81 J		497 J

Qualifiers: J - estimated

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NL INDUSTRIES
SEDIMENT ANALYSES
PHASE III NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS	
	EBAS	OBG
	NL-SD-EPA-13-02	
Grain size	EPA-13	
Depth	6 - 12 inches	
Sive #	**Cumulative %**	
3/8"	0.00	
4	0.00	
10	0.90	
40	10.80	
80	38.50	
100	41.70	
140	48.40	
200	52.90	

NL INDUSTRIES
SOIL ANALYSES
PHASE III NOV, 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS			
	EBAS	OBG	EBAS	OBG
Inorganics (mg/kg)	NL-SO-213-18		NL-SO-217-18	
Depth	18 - 24 inches		18 - 24 inches	
Trace Metals				
Antimony	NA		21 R	
Arsenic	NA		60 J	
Cadmium	NA		28 J	
Chromium	NA		150 J	
Copper	NA		74 J	
Lead	312 J		1750 J	
Selenium	NA		4 J	
Zinc	NA		547 J	

Qualifiers: J - estimated; R - rejected; NA - not analyzed

NL INDUSTRIES
SURFACE WATER ANALYSES
PHASE III
NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS					
	EBAS	OBG	EBAS	OBG	EBAS	OBG
Organics (ug/l)	NL-SW-EPA-02-01		NL-SW-FB-004		NL-TB-002	
Volatiles						
Chloromethane	10 UJ		10 U		5 J	
Bromomethane	10 UJ		10 U		10 UJ	
Vinyl Chloride	10 UJ		10 U		10 UJ	
Chloroethane	10 UJ		10 U		10 UJ	
Methylene Chloride	11 UJ		9 B		10 BJ	
Acetone	10 UJ		26 BJ		10 UJ	
Carbon Disulfide	5 UJ		5 U		5 UJ	
1,1-Dichloroethene	5 UJ		5 U		5 UJ	
1,1-Dichloroethane	5 UJ		5 U		5 UJ	
1,2-Dichloroethene (total)	5 UJ		5 U		5 UJ	
Chloroform	5 UJ		5 U		5 UJ	
1,2-Dichloroethane	21 UJ		22		19 J	
2-Butanone	10 UJ		10 U		10 UJ	
1,1,1-Trichloroethane	5 UJ		5 U		5 UJ	
Carbon Tetrachloride	5 UJ		5 U		5 UJ	
Vinyl Acetate	10 UJ		10 U		10 UJ	
Bromodichloromethane	5 UJ		5 U		5 UJ	
1,2,-Dichloropropane	5 UJ		5 U		5 UJ	
cis-1,3-Dichloropropene	5 UJ		5 U		5 UJ	
Trichloroethene	5 UJ		5 U		5 UJ	
Dibromochloromethane	5 UJ		5 U		5 UJ	
1,1,2-Trichloroethane	5 UJ		5 U		5 UJ	
Benzene	5 UJ		5 U		5 UJ	
trans-1,3-Dichloropropene	5 UJ		5 U		5 UJ	
Bromoform	5 UJ		5 U		5 UJ	
4-Methyl-2-Pentanone	10 UJ		10 U		10 UJ	
2-Hexanone	10 UJ		10 U		10 UJ	
Tetrachloroethene	5 UJ		5 U		5 UJ	
1,1,2,2-Tetrachloroethane	5 UJ		5 U		5 UJ	
Toluene	5 UJ		5 U		5 UJ	
Chlorobenzene	5 UJ		5 U		5 UJ	
Ethylbenzene	5 UJ		5 U		5 UJ	
Styrene	5 UJ		5 U		5 UJ	
Xylene (total)	5 UJ		5 U		5 UJ	

Qualifiers: U - nondetect, J - estimated, B - found in method blank

NL INDUSTRIES
SURFACE WATER ANALYSES
PHASE III
NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS			
	EBAS	OBG	EBAS	OBG
Organics (ug/l)	NL-SW-EPA-02-01		NL-SW-FB-004	
Base/Neutrals/Acids				
Phenol	10 U		10 U	
bis(2-Chloroethyl) ether	10 U		10 U	
2-Chlorophenol	10 U		10 U	
1,3-Dichlorobenzene	10 U		10 U	
1,4-Dichlorobenzene	10 U		10 U	
Benzyl alcohol	10 U		10 U	
1,2-Dichlorobenzene	10 U		10 U	
2-Methylphenol	10 U		10 U	
bis-(2-Chloroisopropyl)ether	10 U		10 U	
4-Methyphenol	10 U		10 U	
N-Nitroso-di-n-propylamine	10 U		10 U	
Hexachloroethane	10 U		10 U	
Nitrobenzene	10 U		10 U	
Isophorone	10 U		10 U	
2-Nitrophenol	10 U		10 U	
2,4-Dimethylphenol	10 U		10 U	
Benzoic acid	50 U		50 U	
bis(2-Chloroethoxy)methane	10 U		10 U	
Naphthalene	10 U		10 U	
4-Chloroaniline	10 U		10 U	
Hexachlorobutadiene	10 U		10 U	
4-Chloro-3-methylphenol	10 U		10 U	
2-Methylnaphthalene	10 U		10 U	
Hexachlorocyclopentadiene	10 U		10 U	
2,4,6-Trichlorophenol	10 U		10 U	
2,4,5-Trichlorophenol	50 U		50 U	
2-Chloronaphthalene	10 U		10 U	
2-Nitroaniline	50 U		50 U	
Dimethylphthalate	10 U		10 U	
Acenaphylene	10 U		10 U	
2,6-Dinitrotoluene	10 U		10 U	
3-Nitroaniline	50 U		50 U	

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NL INDUSTRIES
SURFACE WATER ANALYSES
PHASE III
NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

Organics (ug/l)	LOCATIONS EBAS NL-SW-EPA-02-01	OBG	EBAS NI-SW-FB-004	OBG
Base/Neutrals/Acids Continued:				
Acenaphthene	10 U		10 U	
2,4-Dinitrophenol	50 U		50 U	
4-Nitrophenol	50 U		50 U	
Dibenzofuran	10 U		10 U	
2,4-Dinitrotoluene	10 U		10 U	
Diethylphthalate	10 U		10 U	
4-Chlorophenyl-phenylether	10 U		10 U	
Fluorene	10 U		10 U	
4-Nitroaniline	50 U		50 U	
4,6-Dinitro-2-methylphenol	50 U		50 U	
N-Nitrosodiphenylamine (1)	10 U		10 U	
4-Bromophenyl-phenylether	10 U		10 U	
Hexachlorobenzene	10 U		10 U	
Pentachlorophenol	50 U		50 U	
Phenanthrene	10 U		10 U	
Anthracene	10 U		10 U	
Di-n-butylphthalate	10 U		10 U	
Fluoranthene	10 U		10 U	
Pyrene	10 U		10 U	
Butylbenzylphthalate	10 U		10 U	
3,3'-dichlorobenzidine	20 U		20 U	
Benzo(a)anthracene	10 U		10 U	
Chrysene	10 U		10 U	
bis(2-Ethyhexyl)phthalate	10 U		9 BJ	
Di-n-octylphalate	10 U		10 U	
Benzo(b)fluoranthene	10 U		10 U	
Benzo(k)fluoranthene	10 U		10 U	
Benzo(a)pyrene	10 U		10 U	
Indeno(1,2,3-cd)pyrene	10 U		10 U	
Dibenz(a,h)anthracene	10 U		10 U	
Benzo(g,h,i)perylene	10 U		10 U	

NL INDUSTRIES
SURFACE WATER ANALYSES
PHASE III
NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS			
	EBAS	OBG	EBAS	OBG
Organics (ug/l)	NL-SW-EPA-02-01		NI-SW-FB-004	
Base/Neutrals/Acids Continued:				
Tentatively identified compounds (TICS)				
Total TICS	1		1	
Total TIC Concentration	3.9 JN		9.7 JN	

Qualifiers: U - nondect, J - estimated, B - found in method blank, N - presumptive evidence of a compound

NL INDUSTRIES
SURFACE WATER ANALYSES
PHASE III
NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

Organics (ug/l)	LOCATIONS EBAS NL-SW-EPA-02-01	OBG	EBAS NL-SW-FB-004	OBG
Pesticides/PCBs				
alpha-BHC	0.050 U		0.050 U	
beta-BHC	0.050 U		0.050 U	
delta-BHC	0.050 U		0.050 U	
gamma-BHC (Lindane)	0.050 U		0.050 U	
Heptachlor	0.050 U		0.050 U	
Aldrin	0.050 U		0.050 U	
Heptachlor epoxide	0.050 U		0.050 U	
Endosulfan I	0.050 U		0.050 U	
Dieldrin	0.10 U		0.10 U	
4,4'-DDE	0.10 U		0.10 U	
Endrin	0.10 U		0.10 U	
Endosulfan II	0.10 U		0.10 U	
4,4'-DDD	0.10 U		0.10 U	
Endosulfan sulfate	0.10 U		0.10 U	
4,4'-DDT	0.10 U		0.10 U	
Methoxychlor	0.50 U		0.50 U	
Endrin ketone	0.10 U		0.10 U	
alpha-Chlordane	0.50 U		0.50 U	
gamma-Chlordane	0.50 U		0.50 U	
Toxaphene	1.0 U		1.0 U	
Aroclor-1016	0.50 U		0.50 U	
Aroclor-1221	0.50 U		0.50 U	
Aroclor-1232	0.50 U		0.50 U	
Aroclor-1242	0.50 U		0.50 U	
Aroclor-1248	0.50 U		0.50 U	
Aroclor-1254	1.0 U		1.0 U	
Aroclor-1260	1.0 U		1.0 U	

Qualifiers: U - nondetect

NL INDUSTRIES
SURFACE WATER ANALYSES
PHASE III
NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

Inorganics (ug/l)	LOCATIONS EBAS NL-SW-EPA-02-01	OBG	EBAS NL-SW-EPA-11-01	OBG	EBAS NL-SW-ES-14	OBG
Total Metals						
Aluminum	2250.00		307.00		NA	
Antimony	14.00 U		14.10		NA	
Arsenic	1.00 U		1.90		NA	
Barium	44.80		38.20		NA	
Beryllium	1.30		1.00		NA	
Cadmium	4.40		5.30		NA	
Calcium	17000.00		53100.00		NA	
Chromium	9.00 U		9.00 U		NA	
Cobalt	8.90		41.50		NA	
Copper	5.10		5.70		NA	
Iron	1920.00		8870.00		NA	
Lead	58.20		10.00		37.00 J	
Magnesium	6990.00		29800.00		NA	
Manganese	241.00		7200.00		NA	
Mercury	0.20 U		0.20 U		NA	
Nickel	12.50		38.40		NA	
Potassium	8240.00 J		6680.00 J		NA	
Selenium	2.00 U		2.00 U		NA	
Silver	3.00		21.40		NA	
Sodium	17100.00		213000.00		NA	
Thallium	1.00 U		1.00 U		NA	
Vanadium	3.00 U		3.00 U		NA	
Zinc	67.80		157.00		NA	

Qualifiers: J - estimated; U -nondetect; NA - not analyzed

NL INDUSTRIES
SURFACE WATER ANALYSES
PHASE III
NOV, DEC 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS			
	EBAS	OBG	EBAS	OBG
Inorganics (ug/l)	NL-SW-FB-003		NL-SW-FB-004	
Total Metals				
Aluminum	41.00 U		41.00 U	
Antimony	14.00 U		14.00 U	
Arsenic	1.00 U		1.00 U	
Barium	1.50		1.50	
Beryllium	1.00 U		1.00 U	
Cadmium	3.00 U		3.00 U	
Calcium	189.00		179.00	
Chromium	9.00 U		9.00 U	
Cobalt	3.00 U		3.00 U	
Copper	3.40		4.20	
Iron	40.40		36.40	
Lead	2.00 U		2.00 U	
Magnesium	38.00 U		44.70	
Manganese	2.00 U		2.00 U	
Mercury	0.20 U		0.20 U	
Nickel	6.00 U		6.00 U	
Potassium	480.00 U		480.00 U	
Selenium	2.00 U		2.00 U	
Silver	2.00 U		2.00 U	
Sodium	335.00		259.00	
Thallium	1.00 U		1.00 U	
Vanadium	3.00 U		3.00 U	
Zinc	10.70		5.30	

Qualifiers: J - estimated; U - nondetect

NL '95
Phase III

NL INDUSTRIES
GROUNDWATER ANALYSES
PHASE III NOV, 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

Organics (ug/l)	LOCATIONS EBAS NL-GW-2R2-01 OBG WELL 2R2	OBG	EBAS NL-GW-10R-C OBG WELL 10R	OBG	EBAS NL-GW-19-01 OBG WELL 19	OBG
Volatiles						
Dichlorodifluoromethane	1.0 UJ		1.0 UJ		1.0 UJ	
Chloromethane	1.0 UJ		3.8 UJ		4.1 UJ	
Vinyl Chloride	0.5 UJ		0.5 UJ		0.5 UJ	
Bromomethane	1.0 UJ		1.0 UJ		1.0 UJ	
Chloroethane	1.0 UJ		1.0 UJ		1.0 UJ	
Trichlorofluoromethane	1.0 UJ		1.0 UJ		1.0 UJ	
1,1-Dichloroethene	1.0 UJ		1.0 UJ		1.0 UJ	
Methylene chloride	1.0 UJ		1.1 UJ		1.2 UJ	
trans-1,2-Dichloroethene	1.0 UJ		1.0 UJ		1.0 UJ	
1,1-Dichloroethane	1.0 UJ		1.0 UJ		1.0 UJ	
2,2-Dichloropropane	1.0 UJ		1.0 UJ		1.0 UJ	
cis-1,2-Dichloroethene	1.0 UJ		1.0 UJ		1.0 UJ	
Chloroform	1.0 UJ		1.0 UJ		1.0 UJ	
Bromochloromethane	1.0 UJ		1.0 UJ		1.0 UJ	
1,1,1-Trichloroethane	17 J		1.0 UJ		1.0 UJ	
Carbon tetrachloride	1.0 UJ		1.0 UJ		1.0 UJ	
1,1-Dichloropropene	1.0 UJ		1.0 UJ		1.0 UJ	
Benzene	1.0 UJ		1.0 UJ		1.0 UJ	
1,2-Dichloroethane	14 UJ		16 UJ		22 UJ	
Trichloroethene	1.0 UJ		1.0 UJ		1.0 UJ	
1,2-Dichloropropane	1.0 UJ		1.0 UJ		1.5 UJ	
Bromodichloromethane	1.0 UJ		1.0 UJ		1.0 UJ	
Dibromomethane	1.0 UJ		1.0 UJ		1.0 UJ	
cis-1,3-Dichloropropene	1.0 UJ		1.0 UJ		1.0 UJ	
Toluene	0.1 J		1.0 UJ		1.0 UJ	
trans-1,3-Dichloropropene	1.0 UJ		1.0 UJ		1.0 UJ	
1,1,2-Trichloroethane	1.0 UJ		1.0 UJ		1.0 UJ	
1,3-Dichloropropane	1.0 UJ		1.0 UJ		1.0 UJ	
Tetrachloroethene	1.0 UJ		1.0 UJ		1.0 UJ	
Dibromochloromethane	1.0 UJ		1.0 UJ		1.0 UJ	
1,2-Dibromoethane	1.0 UJ		1.0 UJ		1.0 UJ	
Chlorobenzene	1.0 UJ		1.0 UJ		1.0 UJ	
1,1,1,2-Tetrachloroethane	1.0 UJ		1.0 UJ		1.0 UJ	
Ethylbenzene	1.0 UJ		1.0 UJ		1.0 UJ	
p&m-Xylene	1.0 UJ		1.0 UJ		1.0 UJ	

U = Non detect
J = Estimated
N = Presumptive Evidence of Compound

NLI 002 0894

NL INDUSTRIES
GROUNDWATER ANALYSES
PHASE III NOV, 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

Organics (ug/l)	LOCATIONS EBAS OBG NL-GW-2R2-01 OBG WELL 2R2	EBAS OBG NL-GW-10R-(OBG WELL 10R	EBAS OBG NL-GW-19-01 OBG WELL 19
Volatile (continued)			
o-Xylene	1.0 UJ	1.0 UJ	1.0 UJ
Styrene	1.0 UJ	1.0 UJ	1.0 UJ
Bromoform	1.0 UJ	1.0 UJ	1.0 UJ
Isopropylbenzene	1.0 UJ	1.0 UJ	1.0 UJ
1,1,2,2-Tetrachloroethane	1.0 UJ	1.0 UJ	1.0 UJ
Bromobenzene	1.0 UJ	1.0 UJ	1.0 UJ
1,2,3-Trichloropropane	1.0 UJ	1.0 UJ	1.0 UJ
n-Propylbenzene	1.0 UJ	1.0 UJ	1.0 UJ
2-Chlorotoluene	1.0 UJ	1.0 UJ	1.0 UJ
1,3,5-Trimethylbenzene	1.0 UJ	1.0 UJ	1.0 UJ
4-Chlorotoluene	1.0 UJ	1.0 UJ	1.0 UJ
tert-Butylbenzene	1.0 UJ	1.0 UJ	1.0 UJ
1,2,4-Trimethylbenzene	1.0 UJ	1.0 UJ	1.0 UJ
sec-Butylbenzene	1.0 UJ	1.0 UJ	1.0 UJ
4-Isopropyltoluene	1.0 UJ	1.0 UJ	1.0 UJ
1,3-Dichlorobenzene	1.0 UJ	1.0 UJ	1.0 UJ
1,4-Dichlorobenzene	1.0 UJ	1.0 UJ	1.0 UJ
n-Butylbenzene	0.1 J	0.1 J	0.1 J
1,2-Dichlorobenzene	1.0 UJ	1.0 UJ	1.0 UJ
1,2-Dibromo-3-chloropropane	1.0 UJ	1.0 UJ	1.0 UJ
1,2,4-Trichlorobenzene	1.0 UJ	1.0 UJ	1.0 UJ
Hexachlorobutadiene	1.0 UJ	1.0 UJ	1.0 UJ
Napththalene	0.2 UJ	1.0 UJ	0.1 J
1,2,3-Trichlorobenzene	1.0 UJ	1.0 UJ	1.0 UJ
Tentatively identified compounds (TICS)			
Total Tics	5	1	
Total Tic Concentration	4.72 JN	0.82 N	

Qualifiers: J - estimated, U - nondetect, N - presumptive evidence of a compound

NLI 002 0895

NL INDUSTRIES
GROUNDWATER ANALYSES
PHASE III NOV, 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

Organics (ug/l)	LOCATIONS EBAS NL-FB-001 Field Blank	OBG	EBAS NL-TB-001 Trip Blank	OBG	EBAS NL-DI-001 Deionized water blank	OBG
Volatiles						
Dichlorodifluoromethane	1.0 UJ		1.0 UJ		1.0 UJ	
Chloromethane	3.9 J		3.3 J		2.7 UJ	
Vinyl Chloride	0.5 UJ		0.5 UJ		0.5 UJ	
Bromomethane	1.0 UJ		1.0 UJ		1.0 UJ	
Chloroethane	0.6 J		1.0 UJ		1.0 UJ	
Trichlorofluoromethane	1.0 UJ		1.0 UJ		1.0 UJ	
1,1-Dichloroethene	1.0 UJ		1.0 UJ		1.0 UJ	
Methylene chloride	1.2 J		1.4 J		1.2 UJ	
trans-1,2-Dichloroethene	1.0 UJ		1.0 UJ		1.0 UJ	
1,1-Dichloroethane	1.0 UJ		1.0 UJ		1.0 UJ	
2,2-Dichloropropane	1.0 UJ		1.0 UJ		1.0 UJ	
cis-1,2-Dichloroethene	1.0 UJ		1.0 UJ		1.0 UJ	
Chloroform	1.0 UJ		1.0 UJ		1.0 UJ	
Bromochloromethane	1.0 UJ		1.0 UJ		1.0 UJ	
1,1,1-Trichloroethane	1.0 UJ		1.0 UJ		1.0 UJ	
Carbon tetrachloride	1.0 UJ		1.0 UJ		1.0 UJ	
1,1-Dichloropropene	1.0 UJ		1.0 UJ		1.0 UJ	
Benzene	0.1 J		0.1 J		1.0 UJ	
1,2-Dichloroethane	21 J		21 J		20 UJ	
Trichloroethene	1.0 UJ		1.0 UJ		1.0 UJ	
1,2-Dichloropropane	1.3 J		1.1 J		1.3 UJ	
Bromodichloromethane	1.0 UJ		1.0 UJ		1.0 UJ	
Dibromomethane	1.0 UJ		1.0 UJ		1.0 UJ	
cis-1,3-Dichloropropene	1.0 UJ		1.0 UJ		1.0 UJ	
Toluene	0.3 J		1.0 UJ		1.0 UJ	
trans-1,3-Dichloropropene	1.0 UJ		1.0 UJ		1.0 UJ	
1,1,2-Trichloroethane	1.0 UJ		1.0 UJ		1.0 UJ	
1,3-Dichloropropane	1.0 UJ		1.0 UJ		1.0 UJ	
Tetrachloroethene	1.0 UJ		1.0 UJ		1.0 UJ	
Dibromochloromethane	1.0 UJ		1.0 UJ		1.0 UJ	
1,2-Dibromoethane	1.0 UJ		1.0 UJ		1.0 UJ	
Chlorobenzene	1.0 UJ		1.0 UJ		1.0 UJ	
1,1,1,2-Tetrachloroethane	1.0 UJ		1.0 UJ		1.0 UJ	
Ethylbenzene	0.1 J		1.0 UJ		1.0 UJ	
p&m-Xylene	0.1 J		0.1 J		1.0 UJ	

NL INDUSTRIES
GROUNDWATER ANALYSES
PHASE III NOV, 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

Organics (ug/l)	LOCATIONS EBAS NL-FB-001 Field Blank	OBG	EBAS NL-TB-001 Trip Blank	OBG	EBAS NL-DI-001 Deionized water blank	OBG
Vioatile (continued)						
o-Xylene	1.0 UJ		1.0 UJ		1.0 UJ	
Styrene	1.0 UJ		1.0 UJ		1.0 UJ	
Bromoform	1.0 UJ		1.0 UJ		1.0 UJ	
Isopropylbenzene	1.0 UJ		1.0 UJ		1.0 UJ	
1,1,2,2-Tetrachloroethane	1.0 UJ		1.0 UJ		1.0 UJ	
Bromobenzene	1.0 UJ		1.0 UJ		1.0 UJ	
1,2,3-Trichloropropane	1.0 UJ		1.0 UJ		1.0 UJ	
n-Propylbenzene	1.0 UJ		1.0 UJ		1.0 UJ	
2-Chlorotoluene	1.0 UJ		1.0 UJ		1.0 UJ	
1,3,5-Trimethylbenzene	1.0 UJ		1.0 UJ		1.0 UJ	
4-Chlorotoluene	1.0 UJ		1.0 UJ		1.0 UJ	
tert-Butylbenzene	1.0 UJ		1.0 UJ		1.0 UJ	
1,2,4-Trimethylbenzene	1.0 UJ		1.0 UJ		1.0 UJ	
sec-Butylbenzene	1.0 UJ		1.0 UJ		1.0 UJ	
4-Isopropyltoluene	0.1 J		1.0 UJ		1.0 UJ	
1,3-Dichlorobenzene	1.0 UJ		1.0 UJ		1.0 UJ	
1,4-Dichlorobenzene	1.0 UJ		1.0 UJ		1.0 UJ	
n-Butylbenzene	1.0 UJ		1.0 UJ		1.0 UJ	
1,2-Dichlorobenzene	1.0 UJ		1.0 UJ		1.0 UJ	
1,2-Dibromo-3-chloropropane	1.0 UJ		1.0 UJ		1.0 UJ	
1,2,4-Trichlorobenzene	1.0 UJ		1.0 UJ		1.0 UJ	
Hexachlorobutadiene	1.0 UJ		1.0 UJ		1.0 UJ	
Napththalene	1.0 UJ		1.0 UJ		0.1 J	
1,2,3-Trichlorobenzene	1.0 UJ		1.0 UJ		0.1 J	
Tentatively identified compounds (TICS)						
Total Tics	4		4			
Total Tic Concentration	2.88 JN		3.13 JN			

Qualifiers: J - estimated, U - nondetect, N - presumptive evidence of a compound

NL INDUSTRIES
GROUNDWATER ANALYSES
PHASE III NOV, 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS					
	EBAS	OBG	EBAS	OBG	EBAS	OBG
Organics (ug/l)	NL-GW-10R-01		NL-GW-19-01		NL-FB-001	
	OBG WELL 10R		OBG WELL 1!		Field Blank	
Base/Neutrals/Acids						
Phenol	10 R		10 U		10 U	
bis(2-Chloroethyl) ether	10 U		10 U		10 U	
2-Chlorophenol	10 R		10 U		10 U	
1,3-Dichlorobenzene	10 U		10 U		10 U	
1,4-Dichlorobenzene	10 U		10 U		10 U	
Benzyl alcohol	10 U		10 U		10 U	
1,2-Dichlorobenzene	10 U		10 U		10 U	
2-Methylphenol	10 R		10 U		10 U	
bis-(2-Chloroisopropyl)ether	10 U		10 U		10 U	
4-Methyphenol	10 R		10 U		10 U	
N-Nitroso-di-n-propylamine	10 U		10 U		10 U	
Hexachloroethane	10 U		10 U		10 U	
Nitrobenzene	10 U		10 U		10 U	
Isophorone	10 U		10 U		10 U	
2-Nitrophenol	10 R		10 U		10 U	
2,4-Dimethylphenol	10 R		10 U		10 U	
Benzoic acid	50 R		50 U		50 U	
bis(2-Chloroethoxy)methane	10 U		10 U		10 U	
2,4-Dichlorophenol	10 R		10 U		10 U	
1,2,4-Trichlorobenzene	10 U		10 U		10 U	
Naphthalene	10 U		10 U		10 U	
4-Chloroaniline	10 U		10 U		10 U	
Hexachlorobutadiene	10 U		10 U		10 U	
4-Chloro-3-methylphenol	10 R		10 U		10 U	
2-Methylnaphthalene	10 U		10 U		10 U	
Hexachlorocyclopentadiene	10 U		10 U		10 U	
2,4,6-Trichlorophenol	10 R		10 U		10 U	
2,4,5-Trichlorophenol	50 R		50 U		50 U	
2-Chloronaphthalene	10 U		10 U		10 U	
2-Nitroaniline	50 U		50 U		50 U	
Dimethylphthalate	10 U		10 U		10 U	
Acenaphylene	10 U		10 U		10 U	
2,6-Dinitrotoluene	10 U		10 U		10 U	
3-Nitroaniline	50 U		50 U		50 U	

INDUSTRIES
GROUNDWATER ANALYSES
PHASE III NOV, 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

Organics (ug/l)	LOCATIONS EBAS NL-GW-10R-01	OBG OBG WELL 10R	EBAS NL-GW-19-01	OBG OBG WELL 19	EBAS NL-FB-001	OBG Field blank
Base/Neutrals/Acids (Continued)						
Acenaphthene	10 U		10 U		10 U	
2,4-Dinitrophenol	50 R		50 U		50 U	
4-Nitrophenol	50 R		50 U		50 U	
Dibenzofuran	10 U		10 U		10 U	
2,4-Dinitrotoluene	10 U		10 U		10 U	
Diethylphthalate	10 U		10 U		10 U	
4-Chlorophenyl-phenylether	10 U		10 U		10 U	
Fluorene	10 U		10 U		10 U	
4-Nitroaniline	50 U		50 U		50 U	
4,6-Dinitro-2-methylphenol	50 R		50 U		50 U	
N-Nitrosodiphenylamine (1)	10 U		10 U		10 U	
4-Bromophenyl-phenylether	10 U		10 U		10 U	
Hexachlorobenzene	10 U		10 U		10 U	
Pentachlorophenol	50 R		50 U		50 U	
Phenanthrene	10 U		10 U		10 U	
Anthracene	10 U		10 U		10 U	
Di-n-butylphthalate	10 U		10 U		10 U	
Fluoranthene	10 U		10 U		10 U	
Pyrene	10 U		10 U		10 U	
Butylbenzylphthalate	10 U		10 U		10 U	
3,3'-dichlorobenzidine	20 U		20 U		20 U	
Benzo(a)anthracene	10 U		10 U		10 U	
Chrysene	10 U		10 U		10 U	
bis(2-Ethylhexyl)phthalate	8 J		10 U		10 U	
Di-n-octylphthalate	10 U		10 U		10 U	
Benzo(b)fluoranthene	10 U		10 U		10 U	
Benzo(k)fluoranthene	10 U		10 U		10 U	
Benzo(a)pyrene	10 U		10 U		10 U	
Indeno(1,2,3-cd)pyrene	10 U		10 U		10 U	
Dibenz(a,h)anthracene	10 U		10 U		10 U	
Benzo(g,h,i)perylene	10 U		10 U		10 U	

INDUSTRIES
GROUNDWATER ANALYSES
PHASE III NOV, 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS					
Organics (ug/l)	EBAS	OBG	EBAS	OBG	EBAS	OBG
	NL-GW-10R-01		NL-GW-19-01		NL-FB-001	
	OBG WELL 10R		OBG WELL 19		Field blank	
Base/Neutrals/Acids Continued:						
Tentatively Identified compounds (TICS)						
Total TICS	13				2	
Total TIC Concentration	390.00 JN				80.00 JB	

Qualifiers: J - estimated, U - nondetect, N - presumptive evidence of a compound
R - rejected, B - found in method blank

NL INDUSTRIES
GROUNDWATER ANALYSES
PHASE III NOV, 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

Organics (ug/l)	LOCATIONS EBAS NL-DI-001 Deionized water blank	OBG
Base/Neutrals/Acids		
Phenol	10 U	
bis(2-Chloroethyl) ether	10 U	
2-Chlorophenol	10 U	
1,3-Dichlorobenzene	10 U	
1,4-Dichlorobenzene	10 U	
Benzyl alcohol	10 U	
1,2-Dichlorobenzene	10 U	
2-Methylphenol	10 U	
bis-(2-Chloroisopropyl)ether	10 U	
4-Methyphenol	10 U	
N-Nitroso-di-n-propylamine	10 U	
Hexachloroethane	10 U	
Nitrobenzene	10 U	
Isophorone	10 U	
2-Nitrophenol	10 U	
2,4-Dimethylphenol	10 U	
Benzoic acid	50 U	
bis(2-Chloroethoxy)methane	10 U	
2,4-Dichlorophenol	10 U	
1,2,4-Trichlorobenzene	10 U	
Naphthalene	10 U	
4-Chloroaniline	10 U	
Hexachlorobutadiene	10 U	
4-Chloro-3-methylphenol	10 U	
2-Methylnaphthalene	10 U	
Hexachlorocyclopentadiene	10 U	
2,4,6-Trichlorophenol	10 U	
2,4,5-Trichlorophenol	50 U	
2-Chloronaphthalene	10 U	
2-Nitroaniline	50 U	
Dimethylphthalate	10 U	
Acenaphylene	10 U	
2,6-Dinitrotoluene	10 U	
3-Nitroaniline	50 U	

INDUSTRIES
GROUNDWATER ANALYSES
PHASE III NOV, 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS	
	EBAS	OBG
Organics (ug/l)	NL-DI-001 Deionized water blank	
Base/Neutrals/Acids Continued:		
Acenaphthene	10 U	
2,4-Dinitrophenol	50 U	
4-Nitrophenol	50 U	
Dibenzofuran	10 U	
2,4-Dinitrotoluene	10 U	
Diethylphthalate	10 U	
4-Chlorophenyl-phenylether	10 U	
Fluorene	10 U	
4-Nitroaniline	50 U	
4,6-Dinitro-2-methylphenol	50 U	
N-Nitrosodiphenylamine (1)	10 U	
4-Bromophenyl-phenylether	10 U	
Hexachlorobenzene	10 U	
Pentachlorophenol	50 U	
Phenanthrene	10 U	
Anthracene	10 U	
Di-n-butylphthalate	10 U	
Fluoranthene	10 U	
Pyrene	10 U	
Butylbenzylphthalate	10 U	
3,3'-dichlorobenzidine	20 U	
Benzo(a)anthracene	10 U	
Chrysene	10 U	
bis(2-Ethylhexyl)phthalate	10 U	
Di-n-octylphthalate	10 U	
Benzo(b)fluoranthene	10 U	
Benzo(k)fluoranthene	10 U	
Benzo(a)pyrene	10 U	
Indeno(1,2,3-cd)pyrene	10 U	
Dibenz(a,h)anthracene	10 U	
Benzo(g,h,i)perylene	10 U	

Qualifiers: U - nondetect

NL INDUSTRIES
GROUNDWATER ANALYSES
PHASE III NOV, 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS					
	EBAS	OBG	EBAS	OBG	EBAS	OBG
Organics (ug/l)	NL-GW-10R-01		NL-GW-19-01		NL-FB-001	
	OBG WELL 10R		OBG WELL 19		Field blank	
Pesticides/PCBs						
alpha-BHC	.050 U		.050 U		.050 U	
beta-BHC	.050 U		.050 U		.050 U	
delta-BHC	.050 U		.050 U		.050 U	
gamma-BHC (Lindane)	.050 U		.050 U		.050 U	
Heptachlor	.050 U		.050 U		.050 U	
Aldrin	.050 U		.050 U		.050 U	
Heptachlor epoxide	.050 U		.050 U		.050 U	
Endosulfan I	.050 U		.050 U		.050 U	
Dieldrin	.10 U		.10 U		.10 U	
4,4'-DDE	.10 U		.10 U		.10 U	
Endrin	.10 U		.10 U		.10 U	
Endosulfan II	.10 U		.10 U		.10 U	
4,4'-DDD	.10 U		.10 U		.10 U	
Endosulfan sulfate	.10 U		.10 U		.10 U	
4,4'-DDT	.10 U		.10 U		.10 U	
Methoxychlor	.50 U		.50 U		.50 U	
Endrin ketone	.10 U		.10 U		.10 U	
alpha-Chlordane	.50 U		.50 U		.50 U	
gamma-Chlordane	.50 U		.50 U		.50 U	
Toxaphene	1.00 U		1.00 U		1.00 U	
Aroclor-1016	.50 U		.50 U		.50 U	
Aroclor-1221	.50 U		.50 U		.50 U	
Aroclor-1232	.50 U		.50 U		.50 U	
Aroclor-1242	.50 U		.50 U		.50 U	
Aroclor-1248	.50 U		.50 U		.50 U	
Aroclor-1254	1.00 U		1.00 U		1.00 U	
Aroclor-1260	1.00 U		1.00 U		1.00 U	

Qualifiers: U - nondetect

NL INDUSTRIES
GROUNDWATER ANALYSES
PHASE III NOV, 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS	
Organics (ug/l)	EBAS	OBG
	NL-DI-001	
	Deionized water	
	blank	
Pesticides/PCBs		
alpha-BHC	.050 U	
beta-BHC	.050 U	
delta-BHC	.050 U	
gamma-BHC (Lindane)	.050 U	
Heptachlor	.050 U	
Aldrin	.050 U	
Heptachlor epoxide	.050 U	
Endosulfan I	.050 U	
Dieldrin	.10 U	
4,4'-DDE	.10 U	
Endrin	.10 U	
Endosulfan II	.10 U	
4,4'-DDD	.10 U	
Endosulfan sulfate	.10 U	
4,4'-DDT	.10 U	
Methoxychlor	.50 U	
Endrin ketone	.10 U	
alpha-Chlordane	.50 U	
gamma-Chlordane	.50 U	
Toxaphene	1.00 U	
Aroclor-1016	.50 U	
Aroclor-1221	.50 U	
Aroclor-1232	.50 U	
Aroclor-1242	.50 U	
Aroclor-1248	.50 U	
Aroclor-1254	1.00 U	
Aroclor-1260	1.00 U	

Qualifiers: U - nondetect

NL INDUSTRIES
GROUNDWATER ANALYSES
PHASE III NOV, 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS					
	EBAS	OBG	EBAS	OBG	EBAS	OBG
Inorganics (mg/l)	NL-GW-10R-01		NL-GW-19-01		NL-FB-001	
	OBG WELL 10R		OBG WELL 19		Field Blank	
Total Metals						
Aluminum	69.30		34.00		36.50	
Antimony	16.00 U		16.00 U		16.00 U	
Arsenic	3.00 U		3.00 U		3.00 U	
Barium	26.90		9.50		1.50	
Beryllium	1.00 U		1.00 U		1.00 U	
Cadmium	3.00 U		3.00 U		3.00 U	
Calcium	34300.00		10400.00		99.70	
Chromium	3.00 U		5.10		8.70	
Cobalt	38.10		2.00 U		2.00 U	
Copper	25.50		28.00		11.50	
Iron	429.00		148.00		47.80	
Lead	64.40		2.60		2.00 U	
Magnesium	18900.00		1590.00		14.00 U	
Manganese	3120.00		29.70		3.20	
Mercury	0.20 U		0.20 U		0.20 U	
Nickel	R		R		102.00	
Potassium	7210.00		19300.00		387.00 U	
Selenium	2.00 UJ		2.00 UJ		2.00 UJ	
Silver	3.00 U		3.00 U		3.00 U	
Sodium	37600.00		12700.00		77.00 B	
Thallium	3.00 U		3.00 U		3.00 U	
Vanadium	2.00 U		2.40		2.00 U	
Zinc	110.00		8.80		4.00 U	

Qulifiers: U - nondetect; J - estimated; R - rejected

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NL INDUSTRIES
GROUNDWATER ANALYSES
PHASE III NOV, 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

Inorganics (mg/l)	LOCATIONS EBAS NL-DI-001 Deionized water blank	OBG
Total Metals		
Aluminum	20.00 U	
Antimony	16.00 U	
Arsenic	3.00 U	
Barium	1.00 U	
Beryllium	1.00 U	
Cadmium	3.00 U	
Calcium	75.70	
Chromium	3.00 U	
Cobalt	2.00 U	
Copper	15.00	
Iron	47.60	
Lead	2.00 U	
Magnesium	14.00 U	
Manganese	1.40	
Mercury	0.20 U	
Nickel	13.50	
Potassium	387.00 U	
Selenium	2.00 UJ	
Silver	3.00 U	
Sodium	63.90	
Thallium	3.00 U	
Vanadium	2.00 U	
Zinc	5.60	

Qualifires: U -nondetec; J -estimated; R - rejected

NL INDUSTRIES
GROUNDWATER ANALYSES
PHASE III NOV, 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS	
	EBAS	OBG
	NL-GW-2R2-01	
	OBG WELL 2R2	
Inorganics (mg/l) ?		
Trace Metals	388.00 J	
	4400.00	
Antimony	5	
Arsenic	7.70	
Cadmium	54.60 J	
Chromium	2.00 UJ	
Copper	30.00 U	
Lead	90.60 R	
Selenium		
Vanadium		

Qualifiers:U - nondetec; J -estimated; R - rejected

NLI 002 0907

NL INDUSTRIES
GROUNDWATER ANALYSES
PHASE III NOV, 1990

EBAS=Ebasco Services Inc.
OBG=Obrien & Gere Engineers

	LOCATIONS EBAS NL-GW-2R2-01 OBG WELL 2R2	OBG	EBAS NL-FB-001 Field Blank	OBG
Inorganics (pCi/l)	Filtrate Residue	Filtrate Residue	Filtrate Residue	Filtrate Residue
Radionuclides (pCi/liter)	19.4+/-2.0		<0.1	
	9.4+/-1.0		<0.1	
Potassium-40	104+/-50 J		73+/-30 J	
Potassium-40 (Dissolved)	<1.5		<1.5	
Lead-210	<2.8		<2.8	
Lead-210 (Dissolved)	<2.9 J		<2.4 J	
Radium-226	0.7+/-0.3		0.8+/-0.4	
Radium-226 (Dissolved)	<0.6		<0.13	
Thorium-228	<0.6		0.1+/-0.1	
Thorium-228 (Dissolved)	<0.09		<0.13	
Thorium-230	<0.6		0.2+/-0.2	
Thorium-230 (Dissolved)	<0.13		<0.6	
Thorium-232	8.8+/-2.4 J		21.6+/-2.7 J	
Thorium-232 (Dissolved)	8.3+/-1.9 J		<0.6 J	
Uranium 234	<0.5 J		0.5+/-0.4 J	
Uranium 234 (Dissolved)	<0.6 J		<0.6 J	
Uranium-235	12.1+/-2.8 J		20.9+/-2.7 J	
Uranium-235 (Dissolved)	6.3+/-1.7 J		<0.6 J	
Uranium-238	12.1+/-2.8 J		20.9+/-2.7 J	
Uranium-238 (Dissolved)	6.3+/-1.7 J		<0.6 J	

Qualifiers: J - estimated

APPENDIX B

USEPA PRIVATE POTABLE WELL ANALYTICAL RESULTS

Note: Private well locations shown on aerial photograph.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION II
JACOB K. JAVITS FEDERAL BUILDING
NEW YORK, NEW YORK 10278

AUG 23 1990

Mr. Frank Hale
O'Brien & Gere Engineers, Inc.
440 Viking Drive
Suite 250
Virginia Beach, VA 23452

Re: NL Industries Superfund Site - Requested Guidance Documents

Dear Mr. Hale:

Enclosed are the potable well sampling data collected in 1988 and 1989 by EPA that you requested at the August 17th meeting in Edison, New Jersey. These data should be included in the Remedial Investigation (RI) Report, as was stated in the RI comments and at the meeting.

If you have any questions, please call me at (212) 264-6418.

Sincerely yours,

Michael H. Gilbert

Michael H. Gilbert
Southern New Jersey Compliance Section

Attachment

RECEIVED
AUG 27 1990
O'Brien & Gere Engineers, Inc.
Virginia Beach, VA

NLI 002 0910

NL INDUSTRIES, INC SUPERFUND SITE
Pedricktown, Salem County, New Jersey
Remedial Investigation Potable Well Sampling Program

Joe Cruz
U.S. Route 130, Box 153
Pedricktown, NJ 08067

Potable Well Sample Collected Before Softener on August 17, 1988

PARAMETER	UNIT	VALUE	FEDERAL & STATE STANDARD[a]
pH	standard units	6.0	Federal: 6.5-8.5 State: 5-9 [b]
Antimony	ppm	<.003	NA[c]
Arsenic	ppm	<.001	0.05
Cadmium	ppm	<.001 J	0.01
Chromium	ppm	.011	0.05
Copper	ppm	<.020	1.0[b]
Lead	ppm	.022 J	0.05
Selenium	ppm	<.002	0.01
Total Organic Carbon	ppm	5	NA
Total Organic Halides	ppb	<10	NA
Sulfate	ppm	27	250[b]
Chloride	ppm	43	250[b]
Gross Alpha Radiation	pCi/L	<3.0	15
Gross Beta Radiation	pCi/L	<4.0	NA

Potable Well Sample Collected Before Softener on July 22, 1989

PARAMETER	UNIT	VALUE	FEDERAL & STATE STANDARD[a]
pH	standard units	5.8	Federal: 6.5-8.5 State: 5-9 [b]
Antimony	ppm	.001 M	NA
Arsenic	ppm	.001 U	0.05
Beryllium	ppm	.01 U	NA
Cadmium	ppm	.01[d] U	0.01
Chromium	ppm	.02 U	0.05
Copper	ppm	.01 M	1.0[b]
Lead	ppm	.0097	0.05
Mercury	ppm	.0002 U	0.002
Nickel	ppm	.02 U	NA
Selenium	ppm	.003 M	0.01
Silver	ppm	.01 U	0.05
Thallium	ppm	.001 U	NA
Zinc	ppm	.086	5[b]

NLI 002 0911

NL INDUSTRIES, INC SUPERFUND SITE
Pedricktown, Salem County, New Jersey
Remedial Investigation Potable Well Sampling Program

Raymond Hoffman, Jr.
U.S. Route 130, Box 156
Pedricktown, NJ 08067

Sample Collected Before Softener on August 17, 1988 Before Sufficient Flushing

PARAMETER	UNIT	VALUE	FEDERAL & STATE STANDARD[a]
pH	standard units	5.5	Federal: 6.5-8.5 State: 5-9 [b]
Antimony	ppm	<.003	NA[c]
Arsenic	ppm	.002	0.05
Cadmium	ppm	<.001 J	0.01
Chromium	ppm	.009 J	0.05
Copper	ppm	.253 J	1.0[b]
Lead	ppm	.117 J	0.05
Selenium	ppm	<.002	0.01
Total Organic Carbon	ppm	<1	NA
Total Organic Halides	ppb	N/A	NA
Sulfate	ppm	4	250[b]
Chloride	ppm	12	250[b]
Gross Alpha Radiation	pCi/L	<1	15
Gross Beta Radiation	pCi/L	3.1+/-1.4	NA

Potable Well Sample Collected Before Softener on August 17, 1988 After Sufficient Flushing

PARAMETER	UNIT	VALUE	FEDERAL & STATE STANDARD[a]
Antimony	ppm	<.003	NA[c]
Arsenic	ppm	.003	0.05
Cadmium	ppm	<.001 J	0.01
Chromium	ppm	.005 J	0.05
Copper	ppm	.056 J	1.0[b]
Lead	ppm	.006 J	0.05
Selenium	ppm	<.002	0.01
Total Organic Carbon	ppm	4	NA
Total Organic Halides	ppb	<10	NA
Sulfate	ppm	6	250[b]
Chloride	ppm	11	250[b]
Gross Alpha Radiation	pCi/L	1.6+/-1.3	15
Gross Beta Radiation	pCi/L	3.4+/-1.7	NA

NLI 002 0912

Potable Well Sample Collected Before Softener at Outdoor Spigot on July 22, 1989

PARAMETER	UNIT	VALUE	FEDERAL & STATE STANDARD[a]
pH	standard units	6.2	Federal: 6.5-8.5 State: 5-9 [b]
Antimony	ppm	.001 U	NA
Arsenic	ppm	.001 U	0.05
Beryllium	ppm	.01 U	NA
Cadmium	ppm	.01[d] U	0.01
Chromium	ppm	.02 U	0.05
Copper	ppm	.03 M	1.0[b]
Lead	ppm	.01	0.05
Mercury	ppm	.0002 U	0.002
Nickel	ppm	.02 U	NA
Selenium	ppm	.002 M	0.01
Silver	ppm	.01 U	0.05
Thallium	ppm	.001 U	NA
Zinc	ppm	.02 M	5[b]

NT.T 002 0913

NL INDUSTRIES, INC SUPERFUND SITE
Pedricktown, Salem County, New Jersey
Remedial Investigation Potable Well Sampling Program

Corrosion Control, Inc.
c/o Harry Skilton
U.S. Route 130, Box 156 A
Pedricktown, NJ 08067

Potable Well Sample Collected Before Softener at Outdoor Spigot on August 17, 1988

PARAMETER	UNIT	VALUE	FEDERAL & STATE STANDARD[a]
pH	standard units	5.5	Federal: 6.5-8.5 State: 5-9 [b]
Antimony	ppm	<.003	NA[c]
Arsenic	ppm	.006	0.05
Cadmium	ppm	<.001	0.01
Chromium	ppm	.013	0.05
Copper	ppm	<.02	1.0[b]
Lead	ppm	.002 J	0.05
Selenium	ppm	<.002	0.01
Total Organic Carbon	ppm	5	NA
Total Organic Halides	ppb	<10	NA
Sulfate	ppm	9.8	250[b]
Chloride	ppm	9	250[b]
Gross Alpha Radiation	pCi/L	<1.0	15
Gross Beta Radiation	pCi/L	<2.0	NA

Potable Well Sample Collected Before Softener from Outdoor Spigot on July 22, 1989

PARAMETER	UNIT	VALUE	FEDERAL & STATE STANDARD[a]
pH	standard units	5.4	Federal: 6.5-8.5 State: 5-9 [b]
Antimony	ppm	.001 U	NA
Arsenic	ppm	.003 M	0.05
Beryllium	ppm	.01 U	NA
Cadmium	ppm	.01[d] U	0.01
Chromium	ppm	.02 U	0.05
Copper	ppm	.088	1.0[b]
Lead	ppm	.003 M	0.05
Mercury	ppm	.0002 U	0.002
Nickel	ppm	.02 U	NA
Selenium	ppm	.001 M	0.01
Silver	ppm	.01 U	0.05
Thallium	ppm	.001 M	NA
Zinc	ppm	.015 U	5[b]

NLI 002 0914

NL INDUSTRIES, INC SUPERFUND SITE
Pedricktown, Salem County, New Jersey
Remedial Investigation Potable Well Sampling Program

Guy Eyler
U.S. Route 130, Box 161
Pedricktown, NJ 08067

Potable Well Sample Collected Before Softener on August 17, 1988

PARAMETER	UNIT	VALUE	FEDERAL & STATE STANDARD[a]
pH	standard units	5.4	Federal: 6.5-8.5 State: 5-9 [b]
Antimony	ppm	<.003	NA[c]
Arsenic	ppm	<.001	0.05
Cadmium	ppm	<.001 J	0.01
Chromium	ppm	.012	0.05
Copper	ppm	.057	1.0[b]
Lead	ppm	.008 J	0.05
Selenium	ppm	<.02	0.01
Total Organic Carbon	ppm	2	NA
Total Organic Halides	ppb	<10	NA
Sulfate	ppm	27	250[b]
Chloride	ppm	15	250[b]
Gross Alpha Radiation	pCi/L	<1.0	15
Gross Beta Radiation	pCi/L	6.5+/-1.7	NA

Potable Sample Collected Before Softener at Outdoor Spigot on July 22, 1989

PARAMETER	UNIT	VALUE	FEDERAL & STATE STANDARD[a]
pH	standard units	6.0	Federal: 6.5-8.5 State: 5-9 [b]
Antimony	ppm	.001 M	NA
Arsenic	ppm	.001 U	0.05
Beryllium	ppm	.01 U	NA
Cadmium	ppm	.01[d] U	0.01
Chromium	ppm	.02 U	0.05
Copper	ppm	.04 M	1.0[b]
Lead	ppm	.0058	0.05
Mercury	ppm	.0002 U	0.002
Nickel	ppm	.02 U	NA
Selenium	ppm	.001 U	0.01
Silver	ppm	.01 U	0.05
Thallium	ppm	.001 U	NA
Zinc	ppm	.06 M	5[b]

NL INDUSTRIES, INC SUPERFUND SITE
Pedricktown, Salem County, New Jersey
Remedial Investigation Potable Well Sampling Program

Eleanor Cassano
U.S. Route 130, Box 163
Pedricktown, NJ 08067

Potable Sample Collected Before Softener on August 18, 1988

PARAMETER	UNIT	VALUE	FEDERAL & STATE STANDARD[a]
pH	standard units	4.8	Federal: 6.5-8.5 State: 5-9 [b]
Antimony	ppm	<.003	NA[c]
Arsenic	ppm	.003	0.05
Cadmium	ppm	<.001 J	0.01
Chromium	ppm	.007 J	0.05
Copper	ppm	<.02	1.0[b]
Lead	ppm	.005 J	0.05
Selenium	ppm	<.02	0.01
Total Organic Carbon	ppm	5	NA
Total Organic Halides	ppb	<10	NA
Sulfate	ppm	35	250[b]
Chloride	ppm	25	250[b]
Gross Alpha Radiation	pCi/L	<1.0	15
Gross Beta Radiation	pCi/L	4.8+/-1.6	NA

Potable Well Sample Collected Before Softener at Basement Spigot on July 22, 1989

PARAMETER	UNIT	VALUE	FEDERAL & STATE STANDARD[a]
pH	standard units	6.0	Federal: 6.5-8.5 State: 5-9 [b]
Antimony	ppm	.001 U	NA
Arsenic	ppm	.001 U	0.05
Beryllium	ppm	.01 U	NA
Cadmium	ppm	.01[d] U	0.01
Chromium	ppm	.02 U	0.05
Copper	ppm	.03 M	1.0[b]
Lead	ppm	.0069	0.05
Mercury	ppm	.0002 U	0.002
Nickel	ppm	.02 U	NA
Selenium	ppm	.001 M	0.01
Silver	ppm	.01 U	0.05
Thallium	ppm	.001 U	NA
Zinc	ppm	.086	5[b]

NLI 002 0916

Potable Well Sample Collected After Softener at Kitchen Tap on July 22, 1989

PARAMETER	UNIT	VALUE	FEDERAL & STATE STANDARD[a]
pH	standard units	7.4	Federal: 6.5-8.5 State: 5-9 [b]
Antimony	ppm	.001 U	NA
Arsenic	ppm	.001 U	0.05
Beryllium	ppm	.01 U	NA
Cadmium	ppm	.01[d] U	0.01
Chromium	ppm	.02 U	0.05
Copper	ppm	.01 U	1.0[b]
Lead	ppm	.001 M	0.05
Mercury	ppm	.0002 U	0.002
Nickel	ppm	.02 U	NA
Selenium	ppm	.001 U	0.01
Silver	ppm	.01 U	0.05
Thallium	ppm	.001 M	NA
Zinc	ppm	.015 U	5[b]

NJ.T 002 0917

NL INDUSTRIES, INC SUPERFUND SITE
Pedricktown, Salem County, New Jersey
Remedial Investigation Potable Well Sampling Program

James McCourt, Jr.
U.S. Route 130, Box 151
Pedricktown, NJ 08067

Potable Well Sample Collected on August 18, 1988

PARAMETER	UNIT	VALUE	FEDERAL & STATE STANDARD[a]
pH	standard units	4.7	Federal: 6.5-8.5 State: 5-9 [b]
Antimony	ppm	<.003	NA[c]
Arsenic	ppm	.002	0.05
Cadmium	ppm	.003 J	0.01
Chromium	ppm	.011	0.05
Copper	ppm	.045	1.0[b]
Lead	ppm	.004 J	0.05
Selenium	ppm	<.002	0.01
Total Organic Carbon	ppm	3	NA
Total Organic Halides	ppb	20.5	NA
Sulfate	ppm	85	250[b]
Chloride	ppm	49	250[b]
Gross Alpha Radiation	pCi/L	<5.0	15
Gross Beta Radiation	pCi/L	39+/-7	NA

Potable Well Sample Collected at Bathroom Tap on July 22, 1989

PARAMETER	UNIT	VALUE	FEDERAL & STATE STANDARD[a]
pH	standard units	6.2	Federal: 6.5-8.5 State: 5-9 [b]
Antimony	ppm	.002 M	NA
Arsenic	ppm	.001 U	0.05
Beryllium	ppm	.01 U	NA
Cadmium	ppm	.01[d] U	0.01
Chromium	ppm	.02 U	0.05
Copper	ppm	.096	1.0[b]
Lead	ppm	.005	0.05
Mercury	ppm	.0002 U	0.002
Nickel	ppm	.04 M	NA
Selenium	ppm	.001 U	0.01
Silver	ppm	.01 U	0.05
Thallium	ppm	.001 M	NA
Zinc	ppm	.73	5[b]

NLI 002 0918

NL INDUSTRIES, INC SUPERFUND SITE
Pedricktown, Salem County, New Jersey
Remedial Investigation Potable Well Sampling Program

Michael Wistar
Wistar Company
U.S. Route 130
Pedricktown, NJ 08067

Potable Well Sample Collected Before Softener at Upstairs Spigot on July 22, 1989

PARAMETER	UNIT	VALUE	FEDERAL & STATE STANDARD[a]
pH	standard units	5.8	Federal: 6.5-8.5 State: 5-9 [b]
Antimony	ppm	.001 U	NA
Arsenic	ppm	.001 U	0.05
Beryllium	ppm	.01 U	NA
Cadmium	ppm	.01[d] U	0.01
Chromium	ppm	.02 U	0.05
Copper	ppm	1.4	1.0[b]
Lead	ppm	.400	0.05
Mercury	ppm	.0002 U	0.002
Nickel	ppm	.02 U	NA
Selenium	ppm	.001 M	0.01
Silver	ppm	.01 U	0.05
Thallium	ppm	.001 M	NA
Zinc	ppm	3.2	5.[b]

Potable Well Samples Collected Before Softener at Upstairs Spigot on August 1, 1989

	LEAD LEVEL (ppm)
Federal and State Standard[a]	0.05
After Ten Minutes of Flushing	0.096
After Fifteen Minutes of Flushing	0.027

NLI 002 0919

Potable Well Sample Collected After Softener at Downstairs Tap on August 1, 1989

PARAMETER	UNIT	FIRST SAMPLE	SECOND SAMPLE	FEDERAL & STATE STANDARD[a]
Beryllium	ppm	.005 J	.005 U	NA
Cadmium	ppm	.01[d] U	.01[d] U	0.01
Chromium	ppm	.06[e] U	.06[e] U	0.05
Copper	ppm	.03 M	.063	1.0[b]
Lead	ppm	.001 U	.002 M	0.05
Nickel	ppm	.02 J	.02 U	NA
Silver	ppm	.01 U	.01 U	0.05
Zinc	ppm	.03 U	.03 U	5.[b]

NLI 002 0920

NL INDUSTRIES, INC SUPERFUND SITE
Pedricktown, Salem County, New Jersey
Remedial Investigation Potable Well Sampling Program

Joseph Gates
U.S. Route 130, Box 152
Pedricktown, NJ 08067

Potable Well Sample Collected After Softener at Kitchen Tap on July 22, 1989

PARAMETER	UNIT	VALUE	FEDERAL & STATE STANDARD[a]
pH	standard units	6.6	Federal: 6.5-8.5 State: 5-9 [b]
Antimony	ppm	.001 M	NA
Arsenic	ppm	.001 U	0.05
Beryllium	ppm	.01 U	NA
Cadmium	ppm	.01[d] U	0.01
Chromium	ppm	.02 U	0.05
Copper	ppm	.05 M	1.0[b]
Lead	ppm	.016	0.05
Mercury	ppm	.0002 U	0.002
Nickel	ppm	.02 U	NA
Selenium	ppm	.001 U	0.01
Silver	ppm	.01 U	0.05
Thallium	ppm	.001 U	NA
Zinc	ppm	.015 U	5[b]

NLI 002 0922

[a] Federal and State drinking water standards are identical, except for pH. Unless otherwise noted, Federal standards are the Primary Maximum Contaminant Levels - National Primary Drinking Water Regulations under the Federal Safe Drinking Water Act. Unless otherwise noted, State standards are the Primary Maximum Contaminant Levels as authorized by the New Jersey Safe Drinking Water Act.

[b] Secondary drinking water standard. Secondary Federal standards are the Secondary Maximum Contaminant Levels - National Secondary Drinking Water Regulations under the Federal Safe Drinking Water Act. Secondary State standards are the Secondary Maximum Contaminant Levels as authorized by the New Jersey Safe Drinking Water Act.

Secondary standards set limits for contaminants in drinking water which may affect the aesthetic qualities and the public's acceptance of drinking water (e.g., taste and odor).

[c] Not Available. No Federal or State drinking water standard for this parameter.

[d] Detection limit used was at the drinking water standard for this parameter. Reported value found is below the detection limit, and therefore below the standard.

ppm - Parts per million, equivalent to milligrams per liter.

ppb - Parts per billion, equivalent to micrograms per liter.

J - Reported value is qualified as estimated.

M - Reported value exceeds the detection limit used for this parameter, but is estimated due to proximity to detection limit.

U - Detection limit listed for this parameter. No value is reported, as level is below detection level.

APPENDIX C

SITE PHOTOGRAPHS

West Stream, between Railroad and Rt 130

West Stream, between Pedricktown Road and Railroad,
vicinity of WS-9, WS-10

NLI 002 0926

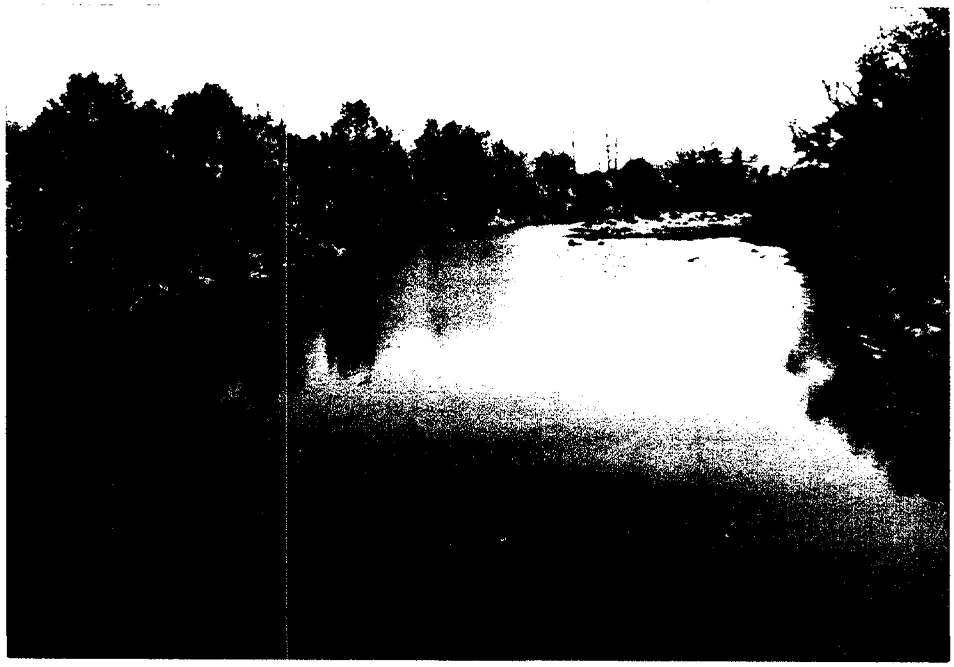
West Stream forest, between Pedricktown Road and Railroad, looking west from plant

NLI 002 0927

Corps of Engineers,
looking south from third ditch cross-over.

Corps of Engineers,
culvert under third ditch cross-over.
(Beginning of tidal influence.)

Corps of Engineers, looking south towards RT 130



Corps of Engineers, culverts between East and West Stream

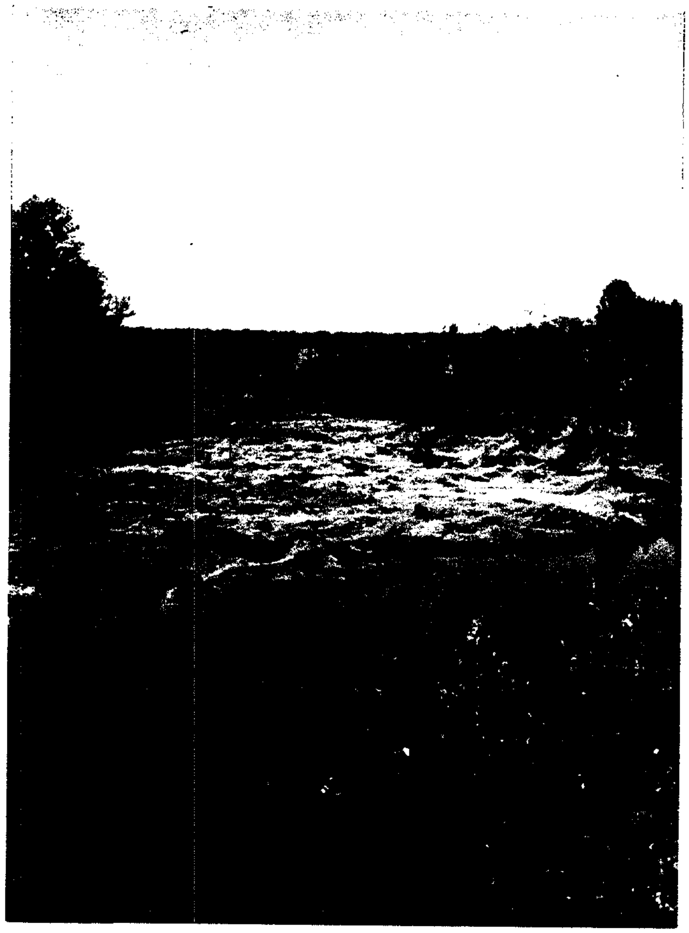
NLI 002 0929

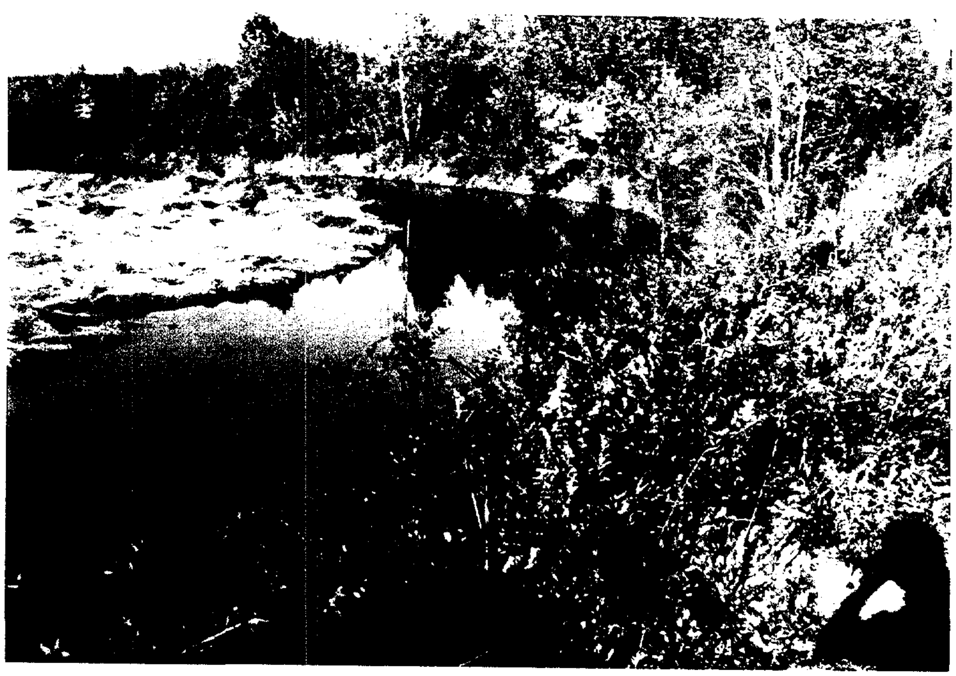
Corps of Engineers,
looking south from first
ditch cross-over

Corps of Engineers,
looking north from first
ditch cross-over.

NLI 002 0930

Corps of Engineers,
vicinity of samples EPA-1, EPA-3, EPA-4





NLI 002 0931

APPENDIX D

REMEDIAL INVESTIGATION REPORT SUMMARY TABLES

NLI 002 0932

APPENDIX D

REMEDIAL INVESTIGATION REPORT SUMMARY TABLES

TABLE 20
NSNJ, INC./NL INDUSTRIES, INC. SITE
CHEMICALS DETECTED IN SOIL SAMPLES

Chemical	On-Site Range	On-Site ND	Off-site Range	Off-site ND	Background Geom. mean	Background Pennsville
Antimony	0.6 - 110	3/7	<20	0/8	NA	NA
Arsenic	2.04 - 11.8	7/7	1.65 - 9.63	8/8	1.18	0.19
Cadmium	<1 - 3.50	2/6	<1	0/8	0.04	0.02
Chromium	5.93 - 19.2	6/6	5.64 - 11.1	8/8	6.27	NA
Copper	5.00 - 24.2	6/6	3.25 - 10.1	8/8	4.77	2.89
Lead	2.91 - 12700	77/77	10.7 - 1770	114/114	12.26	7.77
Zinc	15.8 - 57.2	6/6	14.4 - 38.1	8/8	17.4	23.3

Notes: Concentrations expressed in mg/kg
Background concentrations obtained from NJDEP 1990

ND = Number of Detections

NLI 002 0934

TABLE 22
NSNJ, INC./NL INDUSTRIES, INC. SITE
CHEMICALS DETECTED IN SEDIMENT SAMPLES

Chemical	Reported Range	Reported ND	Background Range	Background ND
WEST STREAM				
Antimony	<30.4 - 477.8	2/3	NA	
Arsenic	3.8 - 280.3	3/3	NA	
Cadmium	2.0 - 21.2	3/3	NA	
Chromium	9.1 - 49.3	3/3	NA	
Copper	33.4 - 187.2	3/3	NA	
Lead	8.6 - 59700.0	52/52	9.6 - 1860.0	8/8
Selenium	0.5 - 2.7	3/3	NA	
Zinc	12.2 - 280.8	3/3	NA	
EAST STREAM				
Lead	<5 - 4350	16/16	36.9 - 206.00	4/4
PONDED WATER				
Lead	8.7 - 2870.0	26/26		

Note: concentrations expressed in mg/kg

ND = Numer of Detections

NA = Not Available

TABLE 23
NSNJ, INC./NL INDUSTRIES, INC. SITE
CHEMICALS DETECTED IN MONITORING WELLS

Chemical	Reported Range	Reported Hits	Background Range	Background Hits
Antimony	<0.003 - 0.122	3/30	NA	
Arsenic	<0.001 - 18.2	21/39	<0.05	0/3
Beryllium	0.003 - 0.156	5/5	NA	
Cadmium	<0.001 - 1.01	46/64	<0.01	0/3
Chromium	0.001 - 4.340	39/39	<0.05	0/3
Copper	0.011 - 4.680	17/33	<0.05	0/3
Lead	<0.001 - 6.290	52/64	<0.005	0/3
Mercury	<0.0002 - 0.0006	2/5	<0.001	0/3
Nickel	<0.04 - 2.48	6.8	NA	
Selenium	<0.002 - 0.004	1/28	<0.01	0/3
Silver	<0.01 - 0.044	2/6	<0.05	0/3
Thallium	<0.001 - 0.003	2/5	NA	
Zinc	0.018 - 9.69	6/6	<0.05 - 0.13	2/3
Chloride	<1 - 150	21/27	13 - 260	3/3
Sulfate	<1 - 24000	61/62	13 - 48	3/3
1,3-Dichlorobenzene	<1 - 1	1/4	<0.5	0/3
1,1-Dichloroethane	<0.5 - 74	1/7	NA	
1,1-Dichloroethene	<0.5 - 170	1/7	<0.5	0/3
Ethylbenzene	<0.5 - 0.5	1/7	NA	
Tetrachloroethene	<0.5 - 180	1/7	<0.5	0/3
Toluene	<0.5 - 1.5	1/7	NA	
1,1,1-trichloroethane	<0.5 - 4700	1/7	<0.5	0/3
vinyl chloride	<1 - 9	1/7	<0.15	0/3
xylenes	<0.5 - 1.5	1/7	NA	
Gross alpha	<0.9 - 570+/-180	7/46		
Gross beta	<2 - 580+/-170	17/37		
Total radium	<2 - 100+/-10	8/9		
Pb-210	<5 - 5.6+/-3.8	1/6		
K-40	<40.0 - 14.0+/-1.0	3/6		
Ra-226	<60 - 1.42+/-0.69	1/4		
Ra-228	<0.8 - 1.8+/-0.6	3/6		
Th-228	<2.0 - 7.02+/-0.70	2/6		
Th-230	.48+/-.29 - 44+/-11	4/4		
Th-232	<0.07 - 0.72+/-0.57	1/4		
U-234	<0.2 - 98.0+/-4.0	4/5		
U-235	<0.08 - 0.14+/-0.1	1/4		
U-238	<0.1 - 3.2+/-0.04	3/4		

Note: * Metals expressed in mg/l; volatile organics expressed in ug/l; radionuclides expressed in pCi/l
* Background concentrations are those obtained from the Pennsgrove Water Supply Company

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TABLE 24
NSNJ, INC./NL INDUSTRIES, INC. SITE
CHEMICALS DETECTED IN PRIVATE GROUND WATER WELLS

Chemical	Reported Range	Reported ND	Background Range	Background ND	New Jersey MCL
Arsenic	<0.001 - 0.006	4/6	<0.05	0/3	0.05
Cadmium	<0.001 - 0.003	2/15	<0.01	0/3	0.01
Chromium	0.005 - 0.013	6/6	<0.05	0/3	0.05
Copper	<0.020 - 0.253	3/6	<0.05	0/3	1.0
Lead	<0.001 - 0.117	10/15	<0.05	[illegible]/3	0.05
Sulfate	4 - 85	6/6	13 - 48	3/3	250
Chloride	9 - 49	6/6	13 - 260	3/3	250
Gross alpha	<1.0 - 1.6+/-1.3	1/7			15
Gross beta	<2.0 - 6.5+/-1.7	5/7			

Note: * Inorganics and MCLs expressed in mg/l; radionuclides expressed in pCi/l

ND = Number of Detections
MCL = Maximum Contaminant Level

TABLE 25
NSNJ, INC./NL INDUSTRIES, INC. SITE
COMPARISON OF WATER CONCENTRATIONS
TO DRINKING WATER STANDARDS

	Maximum Concentration	New Jersey Drinking Water Standard	Comment	Justification for Dropping
METALS (mg/l)				
Antimony	0.122			
Arsenic	18.2	0.05	over	
Beryllium	0.156			
Cadmium	1.01	0.01	over	
Chromium	4.340	0.05	over	
Copper	4.680	1.0	over	
Lead	6.290	0.05	over	
Mercury	0.0006	0.002	within	1 mtxr, within std
Nickel	2.48			
Selenium	0.004	0.01	within	
Silver	0.044	0.05	within	1 mtxr, within std
Thallium	0.003			
Zinc	9.69	5	over	
Chloride	150	250	within	2 mtrx, within std, below bkgd
Sulfate	24000	250	over	
VOLATILES (mg/l)				
1,3-Dichlorobenzene	0.001	0.600	within	within standard
1,1-Dichloroethane	0.074			
1,1-Dichloroethene	0.170	0.002	over	
Ethylbenzene	0.0005	0.680 G	within	within standard
Tetrachloroethene	0.180	0.001	over	
Toluene	0.0015	2.000 G	within	within standard
1,1,1-trichloroethane	4.700	0.026	over	
vinyl chloride	0.009	0.002	over	
xylenes	0.0015	0.044	within	within standard
RADIOACTIVITY (pCi/l)				
Gross alpha	570 +/- 180	15	over	no bkgd data, no known
Gross beta	580 +/- 170			source on-site
Total radium	100 +/- 10	5 M	over	"
Pb-210	5.6 +/- 3.8			"
K-40	14.0 +/- 1.0			"
Ra-226	1.42 +/- 0.69	5	within	"
Ra-228	1.8 +/- 0.6	5	within	"
Th-228	7.02 +/- 0.70			"
Th-230	44 +/- 11			"
Th-232	0.72 +/- 0.57			"
U-234	98.0 +/- 4.0			"
U-235	0.14 +/- 0.1			"
U-238	3.2 +/- 0.04			"

M = USEPA MCL; G = USEPA Maximum Contaminant Level Goal

TABLE 26
NSNJ, INC./NL INDUSTRIES, INC. SITE
SUMMARY OF CHEMICALS OF POTENTIAL CONCERN

	Soils (mg/kg)	Ground Water (mg/l)	Surface Water (mg/l)	Sediments (mg/kg)
METALS				
Antimony	0.6 - 110	<0.003 - 0.122	0.0795	<30.4 - 477.8
Arsenic	2.04 - 11.8	<0.001 - 18.2	0.0607	3.8 - 280.3
Beryllium	NA	0.003 - 0.156	NA	NA
Cadmium	<1 - 3.50	<0.001 - 1.01	0.0140	2.0 - 21.2
Chromium	5.93 - 19.2	0.001 - 4.340	0.0160	9.1 - 49.3
Copper	5.00 - 24.2	0.011 - 4.680	0.0390	33.4 - 187.2
Lead	2.91 - 12700	<0.001 - 6.290	0.0100 - 3.000	<5 - 59700.0
Nickel	NA	<0.04 - 2.48	NA	NA
Selenium	ND	<0.002 - 0.004	ND	0.5 - 2.7
Thallium	NA	<0.001 - 0.003	NA	NA
Zinc	15.8 - 57.2	0.018 - 9.69	0.1622	12.2 - 280.8
Sulfate	NA	<1 - 24000	9 - 1200	NA
VOLATILES				
1,1-Dichloroethane	NA	<0.0005 - 0.074	NA	NA
1,1-Dichloroethene	NA	<0.0005 - 0.170	NA	NA
Tetrachloroethene	NA	<0.0005 - 0.180	NA	NA
1,1,1-trichloroethane	NA	<0.0005 - 4.700	NA	NA
vinyl chloride	NA	<0.001 - 0.009	NA	NA

NA = Not Analyzed
ND = Not Detected

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TABLE 27
NSNJ, INC./NL INDUSTRIES, INC. SITE
CHEMICAL RELEASE SOURCES

Environmental

Receiving Medium	Release Mechanism	Release Source
Air	Fugitive dust	Wastes
Surface water	Surface runoff	Contaminated surface soil
Surface water	Ground water seepage	Contaminated ground water
Ground water	Leaching	Wastes
Ground water	Leaching	Contaminated soil
Ground water	Surface water seepage	Contaminated surface water
Soil	Leaching	Wastes
Soil	Surface runoff	Contaminated surface soil
Soil	Fugitive dust	Wastes
Soil	Tracking	Contaminated surface soil
Sediment	Surface runoff	Wastes
Sediment	Surface runoff	Contaminated surface soil
Biota	Uptake	Contaminated soil, surface water water, sediment

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TABLE 28
NSNJ, INC./NL INDUSTRIES, INC. SITE
POTENTIAL MIGRATION PATHWAYS
AND EXPOSURE POINTS

Release Source	Release Mechanism	Transport Medium	Exposure Point
wastes	fugitive dust	air	on-site air
wastes	fugitive dust	air	off-site air
contaminated GW	GW seepage	SW	West Stream
contaminated GW	GW seepage	SW	East Stream
contaminated SW	SW flow	SW	Delaware River
contaminated soil	surface runoff	SW	Ponded water
contaminated soil	surface runoff	SW	West Stream
contaminated soil	surface runoff	SW	animals
wastes	leaching	GW	on-site wells
contaminated SW	SW seepage	GW	on-site wells
contaminated soil	leaching	GW	on-site wells
contaminated GW	GW seepage	GW	off-site wells
wastes	leaching	soil	on-site
wastes	fugitive dust	soil	on-site
wastes	fugitive dust	soil	off-site
contaminated soil	surface runoff	soil	on-site
contaminated soil	surface runoff	soil	crops
wastes	surface runoff	SW sediment	Ponded water
contaminated soil	surface runoff	SW sediments	Ponded water
SW sediments	SW flow	SW sediments	Delaware River
wastes			on-site

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TABLE 29
NSNJ, INC./NL INDUSTRIES, INC. SITE
POTENTIAL EXPOSURE ROUTES
AND EXPOSURE PATHWAYS

Exposure Medium Exposure Route	Exposure Point	Current Exposures; Current Land Use	Future Exposures; Current Land Use	Future Exposures; Future Land Use
Air				
Inh	on-site	incomplete	complete	complete
Inh	off-site	incomplete	complete	complete
Surface Water				
Ing, derm	West Stream	incomplete	incomplete	incomplete
Ing, derm	East Stream	incomplete	incomplete	incomplete
Ing, derm, fish	Delaware River	complete	complete	complete
Ing, derm	Ponded water	complete	complete	complete
Ground Water				
Ing, inh, derm	on-site wells	incomplete	incomplete	complete
Ing, inh, derm	private wells	incomplete	complete	complete
Soil				
Ing, derm	on-site	complete	complete	complete
Ing, derm	off-site	complete	complete	complete
Sediment				
Ing, derm	Ponded water	complete	complete	complete
Ing, derm	West Stream	incomplete	incomplete	incomplete
Ing, derm	Delaware River	incomplete	incomplete	incomplete
Wastes				
Ing, derm	on-site within fence	incomplete	complete	complete
Foodchain				
Ing	animals, crops	complete	complete	complete

Ing = ingestion, Inh = inhalation, Derm = dermal contact

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TABLE 30
NSNJ, INC./NL INDUSTRIES, INC. SITE
COMPLETE EXPOSURE PATHWAYS

Potentially Exposed Population	Exposure Route/ Medium/ and Exposure Point	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Trespassers	INH/air/on-site	No	No data
On-Site Worker	INH/air/on-site	Yes	Workers would inhale site air
Off-Site Resident	INH/air/off-site	No	No data
Residents	DC, ING, FI/Delaware River	No	Large dilution factor
Trespassers, On-site Workers	DC/SW/site ponded water	Yes	Receptors may contact water which occasionally ponds on-site
Trespassers, On-Site Workers	ING/SW/site ponded water	No	Magnitude of risk is small
Residents	DC, ING, INH/GW/private wells	Yes	Local GW is used for potable water
Off-site Workers	ING/GW/downgradient wells	Yes	Local GW is used for potable water
Off-site Workers	DC/GW/downgradient wells	No	Magnitude of risk is small
Trespassers, On-Site Workers	ING, DC/soil/on-site	Yes	Receptors may contact site soil
Workers	ING, DC/soil/workplace	Yes	Workers may contact contaminated soil at the workplace
Off-Site Residents	ING, DC/soil/off-site residence	Yes	Residents may contact contaminated soils
Trespassers, On-Site Workers	ING, DC/sediment/ponded water	No	Site soil contains higher concentrations than ponded areas; soil exposures are quantified
Residents	ING/game animals & crops	No	Magnitude of risk is small

DC = direct contact, ING = ingestion, INH = inhalation, FI = fish ingestion
GW = ground water, SW = surface water

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TABLE 60
NSNJ, INC./NL INDUSTRIES, INC. SITE
CANCER RISK ESTIMATE FOR AN OFF-SITE CHILD RESIDENT (AGES 10-12)

Exposure Pathway	CDI (mg/kg-day)	SF (mg/kg-dy)-1	Wt. of Evidence	Type of Cancer	SF Source	SF Basis	Chemical-Specific Risk	Total Pathway Risk	Total Exposure Risk
CURRENT EXPOSURES									

RESIDENTIAL SOIL INGESTION									
Arsenic	4.77E-07	1.7E+00	A	skin	IRIS	water	8E-07		
								8E-07	
RESIDENTIAL SOIL DERMAL ABSORPTION									
Arsenic	4.97E-08	1.8E+00 *	A	skin	IRIS	water	9E-08		
								9E-08	
SITE SOIL INGESTION									

Arsenic	1.5E-08	1.7E+00	A	skin	IRIS	water	3E-08		
								3E-08	
SITE SOIL DERMAL ABSORPTION									

Arsenic	1.6E-09	1.8E+00 *	A	skin	IRIS	water	3E-09		
								3E-09	
									9E-07
FUTURE EXPOSURES - TYPE 1									

GW INGESTION									
Arsenic	4.0E-05	1.7E+00	A	skin	IRIS	water	7E-05		
Beryllium	1.667E-05	4.3E+00	B2		IRIS	water	7E-05		
1,1-Dichloroethane	1.762E-04	9.1E-02	C		HEAST	gavage	2E-05		
1,1-Dichloroethene	4.048E-04	6E-01	C		IRIS	water	2E-04		
Tetrachloroethene	4.286E-04	5E-02	B2		HEAST	gavage	2E-05		
Vinyl chloride	2.143E-05	2.3E+00	A	lung	HEAST	diet	5E-05		
								5E-04	
GW DERMAL									
Arsenic	4.7E-08	1.8E+00 *	A	skin	IRIS	water	8E-08		
Beryllium	1.93E-08	4.3E+02 *	B2		IRIS	water	8E-06		
1,1-Dichloroethane	2.04E-07	1.8E-01 *	C		HEAST	gavage	4E-08		
1,1-Dichloroethene	4.70E-07	6E-01 *	C		IRIS	water	3E-07		
Tetrachloroethene	4.97E-07	5E-02 *	B2		HEAST	gavage	2E-08		
Vinyl chloride	2.49E-08	2.3E+00 *	A	lung	HEAST	diet	6E-08		
								9E-06	
GW INHALATION									
1,1-Dichloroethene	2.02E-04 *	1.2E+00	C		IRIS	air	2E-04		

TABLE 60
NSNJ, INC./NL INDUSTRIES, INC. SITE
CANCER RISK ESTIMATE FOR AN OFF-SITE CHILD RESIDENT (AGES 10-12)

Exposure Pathway	CDI (mg/kg-day)	SF (mg/kg-dy)-1	Wt. of Evidence	Type of Cancer	SF Source	SF Basis	Chemical-Specific Risk	Total Pathway Risk	Total Exposure Risk
Tetrachloroethene	4.286E-04	3.3E-03	B2		HEAST	air	1E-06		
Vinyl chloride	2.143E-05	2.95E-01	A	liver	HEAST	air	6E-06		
								3E-04	
RESIDENTIAL SOIL INGESTION									
Arsenic	4.77E-07	1.7E+00	A	skin	IRIS	water	8E-07		
								8E-07	
RESIDENTIAL SOIL DERMAL									
Arsenic	4.97E-08	1.8E+00 *	A	skin	IRIS	water	9E-08		
								9E-08	
									7E-04
FUTURE EXPOSURES - TYPE 2									
GW INGESTION (WELL 2R2)									
Arsenic	4.3E-02	1.7E+00	A	skin	IRIS	water	7E-02		
								7E-02	
GW DERMAL (WELL 2R2)									
Arsenic	5.03E-05	1.8E+00 *	A	skin	IRIS	water	9E-05		
								9E-05	
RESIDENTIAL SOIL INGESTION									
Arsenic	4.77E-07	1.7E+00	A	skin	IRIS	water	8E-07		
								8E-07	
RESIDENTIAL SOIL DERMAL									
Arsenic	4.97E-08	1.8E+00 *	A	skin	IRIS	water	9E-08		
								9E-08	
									7E-02
FUTURE EXPOSURES - TYPE 3									
GW INGESTION (WELL SD)									
Beryllium	3.714E-04	4.3E+00	B2		IRIS	water	2E-03		
								2E-03	
GW DERMAL (WELL SD)									
Beryllium	4.31E-07	4.3E+02 *	B2		IRIS	water	2E-04		
								2E-04	
RESIDENTIAL SOIL INGESTION									
Arsenic	4.77E-07	1.7E+00	A	skin	IRIS	water	8E-07		
								8E-07	

TABLE 60
NSNJ, INC./NL INDUSTRIES, INC. SITE
CANCER RISK ESTIMATE FOR AN OFF-SITE CHILD RESIDENT (AGES 10-12)

Exposure Pathway	CDI (mg/kg-day)	SF (mg/kg-dy)-1	Wt. of Evidence	Type of Cancer	SF Source	SF Basis	Chemical-Specific Risk	Total Pathway Risk	Total Exposure Risk
RESIDENTIAL SOIL DERMAL									
Arsenic	4.97E-08	1.8E+00 *	A	skin	IRIS	water	9E-08		
								9E-08	
									2E-03

* = adjusted for absorption

Future - Type 1 = Ground water exposures are based on site-wide ground water quality
Future - Type 2 = Ground water exposures are based on Well 2R2 ground water quality
Future - Type 3 = Ground water exposures are based on Well SD ground water quality

Note: Lead was not included on the table since a slope factor was not obtained.

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TABLE 61
NSNJ, INC./NL INDUSTRIES, INC. SITE
CANCER RISK ESTIMATE FOR AN OFF-SITE ADULT RESIDENT

Exposure Pathway	CDI (mg/kg/day)	SF (mg/kg-dy)-1	Wt. of Evidence	Type of Cancer	SF Source	SF Basis	Chemical-Specific Risk	Total Pathway Risk	Total Exposure Risk
CURRENT EXPOSURES									
RESIDENTIAL SOIL INGESTION									
Arsenic	8.40E-07	1.7E+00	A	skin	IRIS	water	1E-06		
								1E-06	
RESIDENTIAL SOIL DERMAL									
Arsenic	1.34E-07	1.8E+00 *	A	skin	IRIS	water	2E-07		
								2E-07	
									2E-06
FUTURE EXPOSURES - TYPE 1									
GW INGESTION									
Arsenic	2.1E-04	1.7E+00	A	skin	IRIS	water	4E-04		
Beryllium	8.571E-05	4.3E+00	B2		IRIS	water	4E-04		
1,1-Dichloroethane	9.061E-04	9.1E-02	C		HEAST	gavage	8E-05		
1,1-Dichloroethene	2.082E-03	6E-01	C		IRIS	water	1E-03		
Tetrachloroethene	2.204E-03	5E-02	B2		HEAST	gavage	1E-04		
Vinyl chloride	1.102E-04	2.3E+00	A	lung	HEAST	diet	3E-04		
								2E-03	
GW DERMAL ABSORPTION									
Arsenic	4.0E-07	1.8E+00 *	A	skin	IRIS	water	7E-07		
Beryllium	1.66E-07	4.3E+02 *	B2		IRIS	water	7E-05		
1,1-Dichloroethane	1.76E-06	1.8E-01 *	B2		HEAST	gavage	3E-07		
1,1-Dichloroethene	4.04E-06	6E-01 *	C		IRIS	water	2E-06		
Tetrachloroethene	4.28E-06	5E-02 *	C		HEAST	gavage	2E-07		
Vinyl chloride	2.14E-07	2.3E+00 *	A	lung	HEAST	diet	5E-07		
								8E-05	
GW INHALATION									
1,1-Dichloroethene	1.04E-03 *	1.2E+00	C		IRIS	air	1E-03		
Tetrachloroethene	2.204E-03	3.3E-03	B2		HEAST	air	7E-06		
Vinyl chloride	1.102E-04	2.95E-01	A	liver	HEAST	air	3E-05		
								1E-03	
RESIDENTIAL SOIL INGESTION									
Arsenic	8.40E-07	1.7E+00	A	skin	IRIS	water	1E-06		
								1E-06	
RESIDENTIAL SOIL DERMAL									
Arsenic	1.34E-07	1.8E+00 *	A	skin	IRIS	water	2E-07		
								2E-07	
									4E-03

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TABLE 61

HSNJ, INC./NL INDUSTRIES, INC. SITE

CANCER RISK ESTIMATE FOR AN OFF-SITE ADULT RESIDENT

Exposure Pathway	CDI (mg/kg/day)	SF (mg/kg-dy)-1	Wt. of Evidence	Type of Cancer	SF Source	SF Basis	Chemical-Specific Risk	Total Pathway Risk	Total Exposure Risk
FUTURE EXPOSURES - TYPE 2									
GW INGESTION - WELL 2R2									
Arsenic	2.2E-01	1.7E+00	A	skin	IRIS	water	3E-01		
								3E-01	
GW DERMAL - WELL 2R2									
Arsenic	4.32E-04	1.8E+00 *	A	skin	IRIS	water	8E-04		
								8E-04	
RESIDENTIAL SOIL INGESTION									
Arsenic	8.40E-07	1.7E+00	A	skin	IRIS	water	1E-06		
								1E-06	
RESIDENTIAL SOIL DERMAL									
Arsenic	1.34E-07	1.8E+00 *	A	skin	IRIS	water	2E-07		
								2E-07	
									3E-01
FUTURE EXPOSURES - TYPE 3									
GW INGESTION - WELL SD									
Beryllium	1.910E-03	4.3E+00	B2		IRIS	water	8E-03		
								8E-03	
GW DERMAL - WELL SD									
Beryllium	3.71E-06	4.3E+02 *	B2		IRIS	water	2E-03		
								2E-03	
RESIDENTIAL SOIL INGESTION									
Arsenic	8.40E-07	1.7E+00	A	skin	IRIS	water	1E-06		
								1E-06	
RESIDENTIAL SOIL DERMAL									
Arsenic	1.34E-07	1.8E+00 *	A	skin	IRIS	water	2E-07		
								2E-07	
									1E-02

* = adjusted for absorption

Future - Type 1 = Ground water exposures are based on site-wide ground water quality

Future - Type 2 = Ground water exposures are based on Well 2R2 ground water quality

Future - Type 3 = Ground water exposures are based on Well SD ground water quality

Note: Lead was not included on the table since a slope factor was not obtained.

TABLE 62
NSNJ, INC./NL INDUSTRIES, INC. SITE
CANCER RISK ESTIMATE FOR AN OFF-SITE INDUSTRIAL WORKER

Exposure Pathway	CDI (mg/kg-dy)	SF (mg/kg-dy)-1	Wt. of Evidence	Type of Cancer	SF Source	SF Basis	Chemical-Specific Risk	Total Pathway Risk	Total Exposure Risk
CURRENT EXPOSURES									
INDUSTRIAL SOIL INGESTION									
Arsenic	5.50E-07	1.7E+00	A	skin	IRIS	water	9E-07		
								9E-07	
INDUSTRIAL SOIL DERMAL									
Arsenic	8.76E-08	1.8E+00 *	A	skin	IRIS	water	2E-07		
								2E-07	
									1E-06
FUTURE EXPOSURES - TYPE 1									
GW INGESTION									
Arsenic	7.4E-05	1.7E+00	A	skin	IRIS	water	1E-04		
Beryllium	3.053E-05	4.3E+00	B2		IRIS	water	1E-04		
1,1-Dichloroethane	3.227E-04	9.1E-02	C		HEAST	gavage	3E-05		
1,1-Dichloroethene	7.414E-04	6E-01	C		IRIS	water	4E-04		
Tetrachloroethene	7.850E-04	5E-02	B2		HEAST	gavage	4E-05		
Vinyl chloride	3.925E-05	2.3E+00	A	lung	HEAST	diet	9E-05		
								9E-04	
INDUSTRIAL SOIL INGESTION									
Arsenic	5.50E-07	1.7E+00	A	skin	IRIS	water	9E-07		
								9E-07	
INDUSTRIAL SOIL DERMAL									
Arsenic	8.76E-08	1.8E+00 *	A	skin	IRIS	water	2E-07		
								2E-07	
									9E-04
FUTURE EXPOSURES - TYPE 2									
GW INGESTION - WELL 2R2									
Arsenic	7.937E-02	1.7E+00	A	skin	IRIS	water	1E-01		
								1E-01	
INDUSTRIAL SOIL INGESTION									
Arsenic	5.50E-07	1.7E+00	A	skin	IRIS	water	9E-07		
								9E-07	
INDUSTRIAL SOIL DERMAL									
Arsenic	8.76E-08	1.8E+00 *	A	skin	IRIS	water	2E-07		
								2E-07	
									1E-01

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TABLE 62

NSNJ, INC./NL INDUSTRIES, INC. SITE

CANCER RISK ESTIMATE FOR AN OFF-SITE INDUSTRIAL WORKER

Exposure Pathway	CDI (mg/kg-dy)	SF (mg/kg-dy)-1	Wt. of Evidence	Type of Cancer	SF Source	SF Basis	Chemical-Specific Risk	Total Pathway Risk	Total Exposure Risk
FUTURE EXPOSURES - TYPE 3									

GW INGESTION - WELL SD									
Beryllium	6.803E-04	4.3E+00	B2		IRIS	water	3E-03		
								3E-03	
INDUSTRIAL SOIL INGESTION									
Arsenic	5.50E-07	1.7E+00	A	skin	IRIS	water	9E-07		
								9E-07	
INDUSTRIAL SOIL DERMAL									
Arsenic	8.76E-08	1.8E+00 *	A	skin	IRIS	water	2E-07		
								2E-07	
									3E-03

* = adjusted for absorption

Future - Type 1 = Ground water exposures are based on site-wide ground water quality
Future - Type 2 = Ground water exposures are based on Well 2R2 ground water quality
Future - Type 3 = Ground water exposures are based on Well SD ground water quality

Note: Lead was not included on the table since a slope factor was not obtained.

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TABLE 63

NSNJ, INC./NL INDUSTRIES, INC. SITE

SUBCHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE CHILD RESIDENT (AGES 10-12)

	SDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
CURRENT EXPOSURES									
RESIDENTIAL SOIL ING									
Arsenic	1.11E-05	1E-03	keratosis	HEAST	water	1	1.1E-02		
Chromium	7.24E-06	2E-02	not defined	HEAST	water	100	3.6E-04		
Lead	2E-04 *	8E-04	none observed	EPA 1986	water		2.5E-01		
Zinc	4.4E-05	2E-01	anemia	HEAST	drug	10	2.2E-04	2.6E-01	
RESIDENTIAL SOIL DERM									
Arsenic	1.16E-06	9E-04 *	keratosis	HEAST	water	1	1.3E-03		
Chromium	7.53E-07	6E-04 *	not defined	HEAST	water	100	1.3E-03		
Lead	2E-06	8E-04	none observed	EPA 1986	water		2.5E-03		
Zinc	4.6E-06	4E-02 *	anemia	HEAST	drug	10	1.2E-04		
								5.2E-03	
SITE SOIL ING									
Antimony	8E-07	4E-04	longevity	HEAST	water	1000	2.0E-03		
Arsenic	3.5E-07	1E-03	keratosis	HEAST	water	1	3.5E-04		
Cadmium	5.05E-09 *	5E-04	renal damage	IRIS	water	10	1.0E-05		
Chromium	2.52E-07	2E-02	not defined	HEAST	water	100	1.3E-05		
Lead	1E-04	8E-04	none observed	EPA 1986	water		1.3E-01		
Zinc	1.7E-06	2E-01	anemia	HEAST	drug	10	8.5E-06		
								1.3E-01	
SITE SOIL DERM									
Antimony	8E-08	2E-05 *	longevity	HEAST	water	1000	4.0E-03		
Arsenic	3.7E-08	9E-04 *	keratosis	HEAST	water	1	4.1E-05		
Cadmium	1.05E-08	5E-04	renal damage	IRIS	water	10	2.1E-05		
Chromium	2.63E-08	6E-04 *	not defined	HEAST	water	100	4.4E-05		
Lead	1E-06	8E-04	none observed	EPA 1986	water		1.2E-03		
Zinc	1.8E-07	4E-02 *	anemia	HEAST	drug	10	4.5E-06		
								5.4E-03	
SITE SW DERM									
Lead	7.5E-07	8E-04	none observed		water		9.4E-04		
								9.4E-04	
									0.40

TABLE 63
NSNJ, INC./NL INDUSTRIES, INC. SITE
SUBCHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE CHILD RESIDENT (AGES 10-12)

	SDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
FUTURE EXPOSURES - TYPE 1									

GROUND WATER INGESTION									
Antimony	4.444E-03	4E-04	longevity	HEAST	water	1000	1E+01		
Arsenic	9.4E-04	1E-03	keratosis	HEAST	water	1	9E-01		
Beryllium	3.889E-04	5E-03	none observed	HEAST	water	100	8E-02		
Cadmium	5.00E-04 *	5E-04	renal damage	IRIS	water	10	1E+00		
Chromium	6.278E-03	2E-02	not defined	HEAST	water	100	3E-01		
Lead	6.85E-02 *	8E-04	none observed	EPA 1986	water		9E+01		
Nickel	7.78E-03	2E-02	decr. organ wt.	HEAST	diet	300	4E-01		
Selenium	1.111E-03	4E-03	mortality	HEAST	diet	100	3E-01		
Thallium	5.556E-05	7E-04	blood effects	HEAST	?	300	8E-02		
Zinc	3.35E-02	2E-01	anemia	HEAST	drug	10	2E-01		
1,1-Dichloroethane	4.111E-03	1E+00	none	HEAST	air	100	4E-03		
1,1-Dichloroethene	9.444E-03	9E-03	liver lesions	HEAST	water	1000	1E+00		
Tetrachloroethene	1.000E-02	1E-01	hepatotoxicity	HEAST	gavage	100	1E-01		
1,1,1-Trichloroethane	2.35E-01 *	9E-01	hepatotoxicity	HEAST	air	100	3E-01		
								101.40	
GROUND WATER DERM									
Antimony	5.16E-06	2E-05 *	longevity	HEAST	water	1000	3E-01		
Arsenic	1.10E-06	9E-04 *	keratosis	HEAST	water	1	1E-03		
Beryllium	4.51E-07	5E-05 *	none observed	HEAST	water	100	9E-03		
Cadmium	1.16E-05	5E-04	renal damage	IRIS	water	10	2E-02		
Chromium	7.28E-06	6E-04 *	not defined	HEAST	water	100	1E-02		
Lead	1.59E-04	8E-04	none observed	EPA 1986	water		2E-01		
Nickel	9.02E-06	2E-04 *	decr. organ wt.	HEAST	diet	300	5E-02		
Selenium	1.29E-06	3E-03 *	mortality	HEAST	diet	100	4E-04		
Thallium	6.44E-08	4E-05 *	blood effects	HEAST	?	300	2E-03		
Zinc	3.89E-05	4E-02 *	anemia	HEAST	drug	10	1E-03		
1,1-Dichloroethane	4.77E-06	5E-01 *	none	HEAST	air	100	1E-05		
1,1-Dichloroethene	1.10E-05	9E-03 *	liver lesions	HEAST	water	1000	1E-03		
Tetrachloroethene	1.16E-05	1E-01 *	hepatotoxicity	HEAST	gavage	100	1E-04		
1,1,1-Trichloroethane	3.03E-04	9E-01	hepatotoxicity	HEAST	air	100	3E-04		
								0.55	
GROUND WATER INHALATION									
1,1-Dichloroethane	4.11E-03	1E+00	kidney damage	HEAST	air	100	4E-03		
1,1,1-Trichloroethane	2.611E-01	3E+00	hepatotoxicity	HEAST	air	100	9E-02		
								0.09	

TABLE 63
NSNJ, INC./NL INDUSTRIES, INC. SITE
SUBCHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE CHILD RESIDENT (AGES 10-12)

	SDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
RESIDENTIAL SOIL ING									
Arsenic	1.11E-05	1E-03	keratosis	HEAST	water	1	1.1E-02		
Chromium	7.24E-06	2E-02	not defined	HEAST	water	100	3.6E-04		
Lead	2.00E-04 *	8E-04	none observed	EPA 1986	water		2.5E-01		
Zinc	4.4E-05	2E-01	anemia	HEAST	drug	10	2.2E-04		
								2.6E-01	
RESIDENTIAL SOIL DERM									
Arsenic	1.16E-06	9E-04 *	keratosis	HEAST	water	1	1.3E-03		
Chromium	7.53E-07	6E-04 *	not defined	HEAST	water	100	1.3E-03		
Lead	2E-06	8E-04	none observed	EPA 1986	water		2.5E-03		
Zinc	4.6E-06	4E-02 *	anemia	HEAST	drug	10	1.2E-04		
								5.2E-03	
SITE SOIL ING									
Antimony	8E-07	4E-04	longevity	HEAST	water	1000	2.0E-03		
Arsenic	3.5E-07	1E-03	keratosis	HEAST	water	1	3.5E-04		
Cadmium	5.05E-09 *	5E-04	renal damage	IRIS	water	10	1.0E-05		
Chromium	2.52E-07	2E-02	not defined	HEAST	water	100	1.3E-05		
Lead	1.00E-04 *	8E-04	none observed	EPA 1986	water		1.3E-01		
Zinc	1.7E-06	2E-01	anemia	HEAST	drug	10	8.5E-06		
								1.3E-01	
SITE SOIL DERM									
Antimony	8E-08	2E-05 *	longevity	HEAST	water	1000	4.0E-03		
Arsenic	3.7E-08	9E-04 *	keratosis	HEAST	water	1	4.1E-05		
Cadmium	1.05E-08	5E-04	renal damage	IRIS	water	10	2.1E-05		
Chromium	2.63E-08	6E-04 *	not defined	HEAST	water	100	4.4E-05		
Lead	1E-06	8E-04	none observed	EPA 1986	water		1.2E-03		
Zinc	1.8E-07	4E-02 *	anemia	HEAST	drug	10	4.5E-06		
								5.4E-03	
SITE SW DERM									
Lead	7.5E-07	8E-04	none observed	EPA 1986	water		9.4E-04		
								9.4E-04	
									102.44

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TABLE 63

HSNJ, INC./NL INDUSTRIES, INC. SITE

SUBCHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE CHILD RESIDENT (AGES 10-12)

	SDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
FUTURE EXPOSURES - TYPE 2									
WELL 2R2 - INGESTION									
Arsenic	1.0E+00	1E-03	keratosis	HEAST	water	1	1E+03		
Cadmium	2.78E-05 *	5E-04	renal damage	IRIS	water	10	6E-02		
Chromium	4.444E-04	2E-02	not defined	HEAST	water	100	2E-02		
Lead	1.11E-04 *	8E-04	none observed	EPA 1986	water		1E-01		
								1000.22	
WELL 2R2 - DERMAL									
Arsenic	1.17E-03	9E-04 *	keratosis	HEAST	water	1	1E+00		
Cadmium	6.44E-07	5E-04	renal damage	IRIS	water	10	1E-03		
Chromium	5.16E-07	6E-04 *	not defined	HEAST	water	100	9E-04		
Lead	2.58E-07	8E-04	none observed	EPA 1986	water		3E-04		
								1.30	
RESIDENTIAL SOIL ING									
Arsenic	1.11E-05	1E-03	keratosis	HEAST	water	1	1.1E-02		
Chromium	7.24E-06	2E-02	not defined	HEAST	water	100	3.6E-04		
Lead	2.00E-04 *	8E-04	none observed	EPA 1986	water		2.5E-01		
Zinc	4.4E-05	2E-01	anemia	HEAST	drug	10	2.2E-04		
								2.6E-01	
RESIDENTIAL SOIL DERM									
Arsenic	1.16E-06	9E-04 *	keratosis	HEAST	water	1	1.3E-03		
Chromium	7.53E-07	6E-04 *	not defined	HEAST	water	100	1.3E-03		
Lead	2E-06	8E-04	none observed	EPA 1986	water		2.5E-03		
Zinc	4.6E-06	4E-02 *	anemia	HEAST	drug	10	1.2E-04		
								5.2E-03	
SITE SW DERM									
Lead	7.5E-07	8E-04	none observed	EPA 1986	water		9.4E-04		
								9.4E-04	
									1001.79
FUTURE EXPOSURES - TYPE 3									
WELL SD - INGESTION									
Beryllium	8.667E-03	5E-03	none observed	HEAST	water	100	2E+00		
Cadmium	2.81E-03 *	5E-04	renal damage	IRIS	water	10	6E+00		
Chromium	2.411E-01	2E-02	not defined	HEAST	water	100	1E+01		
Lead	8.17E-03 *	8E-04	none observed	EPA 1986	water		1E+01		

TABLE 63
NSNJ, INC./NL INDUSTRIES, INC. SITE
SUBCHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE CHILD RESIDENT (AGES 10-12)

	SDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
Nickel	1.07E-01	2E-02	decr. organ wt.	HEAST	diet	300	5E+00		
Thallium	1.667E-04	7E-04	blood effects	HEAST	?	300	2E-01		
Zinc	4.80E-01	2E-01	anemia	HEAST	drug	10	2E+00		
								37.61	
WELL SD - DERMAL									
Beryllium	1.01E-05	5E-05 *	none observed	HEAST	water	100	2E-01		
Cadmium	6.51E-05	5E-04	renal damage	IRIS	water	10	1E-01		
Chromium	2.80E-04	6E-04 *	not defined	HEAST	water	100	5E-01		
Lead	1.89E-05	8E-04	none observed	EPA 1986	water		2E-02		
Nickel	1.24E-04	2E-04 *	decr. organ wt.	HEAST	diet	300	6E-01		
Thallium	1.93E-07	4E-05 *	blood effects	HEAST	?	300	5E-03		
Zinc	5.57E-04	4E-02 *	anemia	HEAST	drug	10	1E-02		
								1.46	
RESIDENTIAL SOIL ING									
Arsenic	1.11E-05	1E-03	keratosis	HEAST	water	1	1.1E-02		
Chromium	7.24E-06	2E-02	not defined	HEAST	water	100	3.6E-04		
Lead	2.00E-04 *	8E-04	none observed	EPA 1986	water		2.5E-01		
Zinc	4.4E-05	2E-01	anemia	HEAST	drug	10	2.2E-04		
								2.6E-01	
RESIDENTIAL SOIL DERM									
Arsenic	1.16E-06	9E-04 *	keratosis	HEAST	water	1	1.3E-03		
Chromium	7.53E-07	6E-04 *	not defined	HEAST	water	100	1.3E-03		
Lead	2E-06	8E-04	none observed	EPA 1986	water		2.5E-03		
Zinc	4.6E-06	4E-02 *	anemia	HEAST	drug	10	1.2E-04		
								5.2E-03	
SITE SW DERM									
Lead	7.5E-07	8E-04	none observed	EPA 1986	water		9.4E-04		
								9.4E-04	
									39.34

* = adjusted for absorption
SDIs and RfDs expressed in mg/kg-day

TABLE 64
NSNJ, INC./NL INDUSTRIES, INC. SITE
CHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE ADULT RESIDENT

Exposure Pathway	CDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
CURRENT EXPOSURES									

RESIDENTIAL SOIL ING									
Arsenic	1.96E-06	1E-03	keratosis	HEAST	water	1	2E-03		
Chromium	1.27E-06	5E-03	not defined	IRIS	water	500	3E-04		
Lead	3.00E-05 *	8E-04	none observed	EPA 1986	water		4E-02		
Zinc	7.8E-06	2E-01	anemia	HEAST	drug	10	4E-05		
								4E-02	
RESIDENTIAL SOIL DERM									
Arsenic	3.12E-07	9E-04 *	keratosis	HEAST	water	1	3E-04		
Chromium	2.03E-07	1E-04 *	not defined	IRIS	water	500	2E-03		
Lead	6E-07	8E-04	none observed	EPA 1986			7E-04		
Zinc	1.2E-06	4E-02 *	anemia	HEAST	drug	10	3E-05		
								3E-03	
									0.04
FUTURE EXPOSURES - TYPE 1									

GROUND WATER INGESTION									
Antimony	2.286E-03	4E-04	longevity	IRIS	water	1000	6E+00		
Arsenic	4.9E-04	1E-03	keratosis	HEAST	water	1	5E-01		
Beryllium	2.000E-04	5E-03	none observed	IRIS	water	100	4E-02		
Cadmium	2.57E-04 *	5E-04	renal damage	IRIS	water	10	5E-01		
Chromium	3.229E-03	5E-03	not defined	IRIS	water	500	6E-01		
Lead	3.52E-02 *	8E-04	none observed	EPA 1986	water		4E+01		
Nickel	4.00E-03	2E-02	decr. organ wt.	IRIS	diet	100	2E-01		
Selenium	5.714E-04	3E-03	hair/nail loss	HEAST	diet	15	2E-01		
Thallium	2.857E-05	7E-05	blood effects	HEAST	diet	3000	4E-01		
Zinc	1.72E-02	2E-01	anemia	HEAST	drug	10	9E-02		
1,1-Dichloroethane	2.114E-03	1E-01	none	HEAST	air	1000	2E-02		
1,1-Dichloroethene	4.857E-03	9E-03	liver lesions	IRIS	water	1000	5E-01		
Tetrachloroethene	5.143E-03	1E-02	hepatotoxicity	IRIS	gavage	1000	5E-01		
1,1,1-Trichloroethane	1.21E-01 *	9E-02	hepatotoxicity	IRIS	air	1000	1E+00		
								55	
GROUND WATER DERMAL									
Antimony	4.43E-06	2E-05 *	longevity	IRIS	water	1000	2E-01		

TABLE 64

NSNJ, INC./NL INDUSTRIES, INC. SITE

CHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE ADULT RESIDENT

Exposure Pathway	CDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
Arsenic	9.42E-07	9E-04 *	keratosis	HEAST	water	1	1E-03		
Beryllium	3.88E-07	5E-05 *	none observed	IRIS	water	100	8E-03		
Cadmium	9.98E-06	5E-04	renal damage	IRIS	water	10	2E-02		
Chromium	6.26E-06	1E-04 *	not defined	IRIS	water	500	6E-02		
Lead	1.37E-04	8E-04	none observed	EPA 1986	water		2E-01		
Nickel	7.76E-06	2E-04 *	decr. organ wt.	IRIS	diet	100	4E-02		
Selenium	1.11E-06	3E-03 *	hair/nail loss	HEAST	diet	15	4E-04		
Thallium	5.54E-08	3E-06 *	blood effects	HEAST	diet	3000	2E-02		
Zinc	3.34E-05	4E-02 *	anemia	HEAST	drug	10	8E-04		
1,1-Dichloroethane	4.10E-06	5E-02 *	none	HEAST	air	1000	8E-05		
1,1-Dichloroethene	9.42E-06	9E-03 *	liver lesions	IRIS	water	1000	1E-03		
Tetrachloroethene	9.98E-06	1E-02 *	hepatotoxicity	IRIS	gavage	1000	1E-03		
1,1,1-Trichloroethane	2.61E-04	9E-02	hepatotoxicity	IRIS	air	1000	3E-03		
								5E-01	
GROUND WATER INHALATION									
1,1-Dichloroethane	2.114E-03	1E-01	kidney damage	HEAST	air	1000	2E-02		
1,1-Dichloroethene	4.857E-03	4.86E-03		ECAO			1E+00		
1,1,1-Trichloroethane	1.343E-01	3E-01	hepatotoxicity	HEAST	air	1000	4E-01		
								1E+00	
RESIDENTIAL SOIL ING									
Arsenic	1.96E-06	1E-03	keratosis	HEAST	water	1	2E-03		
Chromium	1.27E-06	5E-03	not defined	IRIS	water	500	3E-04		
Lead	3E-05 *	8E-04	none observed	EPA 1986	water		4E-02		
Zinc	7.8E-06	2E-01	anemia	HEAST	drug	10	4E-05		
								4E-02	
RESIDENTIAL SOIL DERM									
Arsenic	3.12E-07	9E-04 *	keratosis	HEAST	water	1	3E-04		
Chromium	2.03E-07	1E-04 *	not defined	IRIS	water	500	2E-03		
Lead	6E-07	8E-04	none observed	EPA 1986	water		7E-04		
Zinc	1.2E-06	4E-02 *	anemia	HEAST	drug	10	3E-05		
								3E-03	

FUTURE EXPOSURES - TYPE 2

WELL 2R2 - INGESTION							
Arsenic	5.2E-01	1E-03	keratosis	HEAST	water	1	5E+02
Cadmium	1.43E-05 *	5E-04	renal damage	IRIS	water	10	3E-02

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TABLE 64
NSNJ, INC./NL INDUSTRIES, INC. SITE
CHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE ADULT RESIDENT

Exposure Pathway	CDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
Chromium	2.286E-04	5E-03	not defined	IRIS	water	500	5E-02		
Lead	5.72E-05 *	8E-04	none observed	EPA 1986	water		7E-02		
								520.1	
WELL 2R2 - DERMAL									
Arsenic	1.01E-03	9E-04 *	keratosis	HEAST	water	1	1E+00		
Cadmium	5.54E-07	5E-04	renal damage	IRIS	water	10	1E-03		
Chromium	4.43E-07	1E-04 *	not defined	IRIS	water	500	4E-03		
Lead	2.22E-07	8E-04	none observed	EPA 1986	water		3E-04		
								1.1	
RESIDENTIAL SOIL ING									
Arsenic	1.96E-06	1E-03	keratosis	HEAST	water	1	2E-03		
Chromium	1.27E-06	5E-03	not defined	IRIS	water	500	3E-04		
Lead	3E-05 *	8E-04	none observed	EPA 1986	water		4E-02		
Zinc	7.8E-06	2E-01	anemia	HEAST	drug	10	4E-05		
								0.04	
RESIDENTIAL SOIL DERM									
Arsenic	3.12E-07	9E-04 *	keratosis	HEAST	water	1	3E-04		
Chromium	2.03E-07	1E-04 *	not defined	IRIS	water	500	2E-03		
Lead	6E-07	8E-04	none observed	EPA 1986	water		7E-04		
Zinc	1.2E-06	4E-02 *	anemia	HEAST	drug	10	3E-05		
								3E-03	
									521.3

FUTURE EXPOSURES - TYPE 3

Exposure Pathway	CDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
WELL SD - INGESTION									
Beryllium	4.457E-03	5E-03	none observed	IRIS	water	100	9E-01		
Cadmium	1.45E-03 *	5E-04	renal damage	IRIS	water	10	3E+00		
Chromium	1.240E-01	5E-03	not defined	IRIS	water	500	2E+01		
Lead	4.20E-03 *	8E-04	none observed	EPA 1986	water		5E+00		
Nickel	5.51E-02	2E-02	decr. organ wt.	IRIS	diet	100	3E+00		
Thallium	8.571E-05	7E-05	blood effects	HEAST	diet	3000	1E+00		
Zinc	2.47E-01	2E-01	anemia	HEAST	drug	10	1E+00		
								39.1	
WELL SD - DERMAL									
Beryllium	8.65E-06	5E-05 *	none observed	IRIS	water	100	2E-01		
Cadmium	5.60E-05	5E-04	renal damage	IRIS	water	10	1E-01		
Chromium	2.41E-04	1E-04 *	not defined	IRIS	water	500	2E+00		

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TABLE 64

NSNJ, INC./NL INDUSTRIES, INC. SITE

CHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE ADULT RESIDENT

Exposure Pathway	CDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
Lead	1.63E-05	8E-04	none observed	EPA 1986	water		2E-02		
Nickel	1.07E-04	2E-04 *	decr. organ wt.	IRIS	diet	100	5E-01		
Thallium	1.66E-07	3E-06 *	blood effects	HEAST	diet	3000	6E-02		
Zinc	4.79E-04	4E-02 *	anemia	HEAST	drug	10	1E-02		
								3.3	
RESIDENTIAL SOIL ING									
Arsenic	1.96E-06	1E-03	keratosis	HEAST	water	1	2E-03		
Chromium	1.27E-06	5E-03	not defined	IRIS	water	500	3E-04		
Lead	3E-05 *	8E-04	none observed	EPA 1986	water		4E-02		
Zinc	7.8E-06	2E-01	anemia	HEAST	drug	10	4E-05		
								4E-02	
RESIDENTIAL SOIL DERM									
Arsenic	3.12E-07	9E-04 *	keratosis	HEAST	water	1	3E-04		
Chromium	2.03E-07	1E-04 *	not defined	IRIS	water	500	2E-03		
Lead	6E-07	8E-04	none observed	EPA 1986	water		7E-04		
Zinc	1.2E-06	4E-02 *	anemia	HEAST	drug	10	3E-05		
								3E-03	
									42.4

Note: CDIs and RfDs expressed in mg/kg-day

* = adjusted for absorption

ING = ingestion, DERM = dermal absorption

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TABLE 65
NSNJ, INC./NL INDUSTRIES, INC. SITE
CHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE INDUSTRIAL WORKER

Exposure Pathway	CDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
CURRENT EXPOSURES									
INDUSTRIAL SOIL ING.									
Arsenic	1.28E-06	1E-03	keratosis	HEAST	water	1	1.3E-03		
Chromium	2.14E-06	5E-03	not defined	IRIS	water	500	4.3E-04		
Lead	3.5E-05 *	8E-04	none observed	EPA 1986	water		4.4E-02		
Zinc	4.5E-06	2E-01	anemia	HEAST	drug	10	2.3E-05		
								4.5E-02	
INDUSTRIAL SOIL DERMAL									
Arsenic	2.04E-07	9E-04 *	keratosis	HEAST	water	1	2.3E-04		
Chromium	3.40E-07	1E-04 *	not defined	IRIS	water	500	3.4E-03		
Lead	7E-07	8E-04	none observed	EPA 1986	water		8.8E-04		
Zinc	7.1E-07	4E-02 *	anemia	HEAST	drug	10	1.8E-05		
								4.5E-03	
									0.05
FUTURE EXPOSURES - TYPE 1									
GROUND WATER INGESTION									
Antimony	8.141E-04	4E-04	longevity	IRIS	water	1000	2E+00		
Arsenic	1.7E-04	1E-03	keratosis	HEAST	water	1	2E-01		
Beryllium	7.123E-05	5E-03	none observed	IRIS	water	100	1E-02		
Cadmium	9.15E-05 *	5E-04	renal damage	IRIS	water	10	2E-01		
Chromium	1.150E-03	5E-03	not defined	IRIS	water	500	2E-01		
Lead	1.26E-02 *	8E-04	none observed	EPA 1986	water		2E+01		
Nickel	1.42E-03	2E-02	decr. organ wt.	IRIS	diet	100	7E-02		
Selenium	2.035E-04	3E-03	hair/nail loss	HEAST	diet	15	7E-02		
Thallium	1.018E-05	7E-05	blood effects	HEAST	diet	3000	1E-01		
Zinc	6.14E-03	2E-01	anemia	HEAST	drug	10	3E-02		
1,1-Dichloroethane	7.530E-04	1E-01	none	HEAST	air	1000	8E-03		
1,1-Dichloroethene	1.730E-03	9E-03	liver lesions	IRIS	water	1000	2E-01		
Tetrachloroethene	1.832E-03	1E-02	hepatotoxicity	IRIS	gavage	1000	2E-01		
1,1,1-Trichloroethane	4.30E-02 *	9E-02	hepatotoxicity	IRIS	air	1000	5E-01		
								19.56	

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TABLE 65
NSNJ, INC./NL INDUSTRIES, INC. SITE
CHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE INDUSTRIAL WORKER

Exposure Pathway	CDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
INDUSTRIAL SOIL INGESTION									
Arsenic	1.28E-06	1E-03	keratosis	HEAST	water	1	1E-03		
Chromium	2.14E-06	5E-03	not defined	IRIS	water	500	4E-04		
Lead	3.50E-05 *	8E-04	none observed	EPA 1986	water		4E-02		
Zinc	4.5E-06	2E-01	anemia	HEAST	drug	10	2E-05		
								5E-02	
INDUSTRIAL SOIL DERMAL									
Arsenic	2.04E-07	9E-04 *	keratosis	HEAST	water	1	2E-04		
Chromium	3.40E-07	1E-04 *	not defined	IRIS	water	500	3E-03		
Lead	7E-07	8E-04	none observed	EPA 1986	water		9E-04		
Zinc	7.1E-07	4E-02 *	anemia	HEAST	drug	10	2E-05		
								5E-03	
									19.(
FUTURE EXPOSURES - TYPE 2									
WELL 2R2 INGESTION									
Arsenic	1.852E-01	1E-03	keratosis	HEAST	water	1	2E+02		
Cadmium	5.09E-06 *	5E-04	renal damage	IRIS	water	10	1E-02		
Chromium	8.141E-05	5E-03	not defined	IRIS	water	500	2E-02		
Lead	2.03E-05 *	8E-04	none observed	EPA 1986	water		3E-02		
								185	
INDUSTRIAL SOIL INGESTION									
Arsenic	1.28E-06	1E-03	keratosis	HEAST	water	1	1E-03		
Chromium	2.14E-06	5E-03	not defined	IRIS	water	500	4E-04		
Lead	3.50E-05 *	8E-04	none observed	EPA 1986	water		4E-02		
Zinc	4.5E-06	2E-01	anemia	HEAST	drug	10	2E-05		
								5E-02	
INDUSTRIAL SOIL DERMAL									
Arsenic	2.04E-07	9E-04 *	keratosis	HEAST	water	1	2E-04		
Chromium	3.40E-07	1E-04 *	not defined	IRIS	water	500	3E-03		
Lead	7E-07	8E-04	none observed	EPA 1986	water		9E-04		
Zinc	7.1E-07	4E-02 *	anemia	HEAST	drug	10	2E-05		
								5E-03	
									185

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TABLE 65
NSNJ, INC./NL INDUSTRIES, INC. SITE
CHRONIC HAZARD INDEX ESTIMATE FOR AN OFF-SITE INDUSTRIAL WORKER

Exposure Pathway	CDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
FUTURE EXPOSURES - TYPE 3									
WELL SD INGESTION									
Beryllium	1.587E-03	5E-03	none observed	IRIS	water	100	3E-01		
Cadmium	5.14E-04 *	5E-04	renal damage	IRIS	water	10	1E+00		
Chromium	4.416E-02	5E-03	not defined	IRIS	water	500	9E+00		
Lead	1.50E-03 *	8E-04	none observed	EPA 1986	water		2E+00		
Nickel	1.964E-02	2E-02	decr. organ wt.	IRIS	diet	100	1E+00		
Thallium	3.053E-05	7E-05	blood effects	HEAST	diet	3000	4E-01		
Zinc	8.792E-02	2E-01	anemia	HEAST	drug	10	4E-01		
								14	
INDUSTRIAL SOIL INGESTION									
Arsenic	1.28E-06	1E-03	keratosis	HEAST	water	1	1E-03		
Chromium	2.14E-06	5E-03	not defined	IRIS	water	500	4E-04		
Lead	3.50E-05 *	8E-04	none observed	EPA 1986	water		4E-02		
Zinc	4.5E-06	2E-01	anemia	HEAST	drug	10	2E-05		
								5E-02	
INDUSTRIAL SOIL DERMAL									
Arsenic	2.04E-07	9E-04 *	keratosis	HEAST	water	1	2E-04		
Chromium	3.40E-07	1E-04 *	not defined	IRIS	water	500	3E-03		
Lead	7E-07	8E-04	none observed	EPA 1986	water		9E-04		
Zinc	7.1E-07	4E-02 *	anemia	HEAST	drug	10	2E-05		
								5E-03	
									14

* = adjusted for absorption

CDIs and RfDs expressed in mg/kg-day

TABLE 66
NSNJ, INC./NL INDUSTRIES, INC. SITE
CANCER RISK ESTIMATE FOR AN ON-SITE WORKER

Exposure Pathway	CDI (mg/kg/day)	SF (mg/kg-dy)-1	Wt. of Evidence	Type of Cancer	SF Source	SF Basis	Chemical-Specific Risk	Total Pathway Risk	Total Exposure Risk
FUTURE EXPOSURES									

SITE SOIL INGESTION									
Arsenic	1.0E-06	1.7E+00	A	skin	IRIS	water	2E-06		
								2E-06	
SITE SOIL DERMAL									
Arsenic	1.64E-07	1.8E+00 *	A	skin	IRIS	water	3E-07		
								3E-07	
SITE AIR INHALATION									
Arsenic	1.09E-08 *	5.0E+01	A	respir.	HEAST	air	5E-07		
Cadmium	1.08E-08	6.1E+00	B1		IRIS	occup	7E-08		
Chromium	5.82E-08	4.1E+01	A	lung	IRIS	occup	2E-06		
								3E-06	
									5E-06

* = adjusted for absorption

Note: Lead was not included on the table since a slope factor was not obtained.

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TABLE 67
NSNJ, INC./NL INDUSTRIES, INC. SITE
CHRONIC HAZARD INDEX ESTIMATE FOR AN ON-SITE WORKER

Exposure Pathway	CDI	RfD	Critical Effect	RfD Source	RfD Basis	RfD Uncert. Factor Adjust.	Hazard Quotient	Pathway Hazard Index	Total Exposure Hazard Index
FUTURE EXPOSURES									

SITE SOIL INGESTION									
Antimony	2E-05	4E-04	longevity	IRIS	water	1000	5E-02		
Arsenic	2.4E-06	1E-03	keratosis	HEAST	water	1	2E-03		
Cadmium	3.56E-08 *	5E-04	renal damage	IRIS	water	10	7E-05		
Chromium	3.85E-06	5E-03	not defined	IRIS	water	500	8E-04		
Lead	5E-04 *	8E-04	none observed	EPA 1986	water		6E-01		
Zinc	1.1E-05	2E-01	anemia	HEAST	drug	10	6E-05		
								0.68	
SITE SOIL DERMAL									
Antimony	3.11E-06	2E-05 *	longevity	IRIS	water	1000	2E-01		
Arsenic	3.82E-07	9E-04 *	keratosis	HEAST	water	1	4E-04		
Cadmium	1.13E-07	5E-04	renal damage	IRIS	water	10	2E-04		
Chromium	6.12E-07	1E-04 *	not defined	IRIS	water	500	6E-03		
Lead	1E-05	8E-04	none observed	EPA 1986	water		1E-02		
Zinc	1.8E-06	4E-02 *	anemia	HEAST	drug	10	5E-05		
								0.17	
SURFACE WATER DERMAL									
Lead	7.6E-06	8E-04	none observed	EPA 1986	water		1E-02		
								0.01	
									0.9

Note: CDIs and RfDs expressed in mg/kg-day

* = adjusted for absorption

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APPENDIX E

FEDERAL REGISTER, LEAD ATTAINMENT AREAS

longitude 118°28'32" W.; thence southwesterly to latitude 33°26'53.5 N., longitude 118°28'35" W.

(b) No vessel may anchor in this area.

(c) For the purposes of this section, "vessel" means every description of watercraft or other artificial contrivance used, or capable of being used, as a means of transportation on water.

(33 U.S.C. 1225, 1231; 49 CFR 1.46(n) (4))

Dated: February 20, 1985.

F.P. Schubert,

Rear Admiral, U.S. Coast Guard, Commander, Eleventh Coast Guard District.

[FR Doc. 85-4525 Filed 2-22; 8:45 am]

BILLING CODE 4910-14-M

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 52

[Region II Docket No. 42; A-2-FRL-2783-6]

Approval and Promulgation of Implementation Plans; New Jersey Lead Plan

AGENCY: Environmental Protection Agency.

ACTION: Supplemental notice of proposed rulemaking.

SUMMARY: This notice announces receipt by the Environmental Protection Agency (EPA) of supplemental information submitted by the State of New Jersey with regard to its State Implementation Plan (SIP) for attainment and maintenance of the national ambient air quality standard for lead in all areas of the State. It also reproposes approval of the State's lead SIP, which was submitted under the requirements of the Clean Air Act.

EPA has carried out its review of the New Jersey lead SIP concurrently with the State's SIP development process under the terms of "parallel processing" (this procedure is discussed in a June 23, 1982 Federal Register notice (47 FR 27073)). "Parallel processing" is designed to expedite EPA actions on SIP revisions.

The need for New Jersey's current submittal was identified by EPA in its December 29, 1983 Federal Register notice (48 FR 57331) proposing to approve the New Jersey lead SIP. In determining the nature of its final rulemaking on the New Jersey lead SIP, EPA will consider, along with the public comments it receives, the State's future submittals and actions in response to issues that are identified in today's Federal Register notice.

DATES: Interested persons are invited to submit comments on this proposed action on or before April 26, 1985.

ADDRESSES: All comments should be addressed to: Christopher J. Daggett, Regional Administrator, Environmental Protection Agency, Regional II Office, Jacob K. Javits Federal Building, 26 Federal Plaza, New York, New York 10278.

Copies of the proposed revision, including the supplemental information, are available for public inspection during normal business hours at:

Environmental Protection Agency, Region II, Jacob K. Javits Federal Building, 26 Federal Plaza, Room 1005, New York, New York 10278

New Jersey Department of Environmental Protection, Labor and Industry Building, John Fitch Plaza, Trenton, New Jersey 08625.

FOR FURTHER INFORMATION CONTACT: William S. Baker, Chief, Air Programs Branch, Environmental Protection Agency, Region II, Jacob K. Javits Federal Building, 26 Federal Plaza, New York, New York 10278, 212-264-2517.

SUPPLEMENTARY INFORMATION:

I. Background

On October 6, 1983, as required by section 110 of the Clean Air Act, New Jersey submitted to the Environmental Protection Agency (EPA) a draft State Implementation Plan (SIP) for attainment and maintenance of the national ambient air quality standard for lead. After review of the draft SIP, on December 29, 1983 (48 FR 57331) EPA proposed to approve it. However, in its Federal Register notice of proposed rulemaking, EPA stated that final approval would be contingent upon EPA's receipt of certain supplemental information for the State. EPA also indicated that if this supplemental information showed that significant changes had been made to the SIP, EPA would have to repropose action on the SIP in order to provide the public with the opportunity to comment on the revised SIP, as well as on EPA's evaluation of it.

A. New Jersey's Lead SIP Development Process

In response to the requirements set forth in EPA's December 29, 1983 notice of proposed rulemaking, New Jersey issued a proposed lead SIP, dated January 1984, and conducted a public hearing on this SIP on February 22, 1984. Based on the public comments that State received on this proposed SIP, and on a March 21, 1984 letter from EPA to the State requesting additional information on several of its elements, New Jersey decided to make substantial additions and revisions to its January 1984 document. Consequently, a reproposed June 1984, SIP document was issued and a second public hearing was held on August 2, 1984.

B. EPA's Processing of New Jersey's Lead SIP

Information supplementing New Jersey's original October 6, 1983 draft SIP has been submitted to EPA on May 1, June 18, and August 15, 1984, and on February 7, 1985. Due to the substantive nature of this supplemental information, EPA has determined that today's supplemental notice of proposed rulemaking on the New Jersey lead SIP is warranted.

The purpose of today's notice is to provide the public with an opportunity to comment on the contents of this supplemental information and on EPA's analysis of it. The public is also being provided with an additional opportunity to comment on EPA's proposed approval of the New Jersey lead SIP. All public comments received on EPA's December 29, 1983 notice of proposed rulemaking, today's notice, and comments received by EPA during the course of the comment periods established by the State will be addressed in EPA's notice of final rulemaking on the New Jersey lead SIP.

II. Results of EPA Review

Today's Federal Register notice provides a summary of the supplemental information submitted by the State and the results of EPA's review of it. The analysis is presented under the following headings:

A. Attainment Demonstration: Urban Areas
B. Attainment Demonstration: Significant Point Sources
C. Fugitive Emissions
D. Control Measures

More detailed information concerning EPA's review of this supplemental information is contained in a Technical Support Document to today's notice. This document is available for public inspection at the locations identified in the ADDRESSES section of this notice.

A. Attainment Demonstration: Urban Areas

In its December 29, 1983 notice of proposed rulemaking, EPA required the State to submit attainment demonstrations for the cities of Newark, Jersey City, and Trenton, three urban areas in New Jersey which have experienced recent violations of the air quality standard for lead. In its supplemental submittal, the State addressed this requirement by providing a statistical analysis of the relationship between decreases in lead in the ambient air and the reduction of lead in gasoline in these cities. The quantity of lead in gasoline and ambient air concentrations of lead were found to be closely related. Since the quantity of lead in gasoline in 1990 will be only 26.4% of its 1982 value, the State expects that the average ambient lead concentration in 1990 will be reduced by the same percentage. In 1982 no urban areas in New Jersey experienced violations of the lead standard. Thus, the ambient lead concentration is presently below the standard and will continue to decrease to well below the standard in the future. It also should be noted that in an August 2, 1984 Federal Register notice (49 FR 31032), EPA proposed additional reductions to the lead content of gasoline. These additional reductions are not reflected in the State's analysis.

EPA has determined that this demonstration of attainment and maintenance of the lead standard in urban areas is adequate, and finds it approvable.

B. Attainment Demonstration: Significant Point Sources

EPA's December 29, 1983 notice of proposed rulemaking required the State to submit a demonstration of attainment and maintenance of the lead standard in the vicinity of certain "significant" point sources. (A "significant" point source is any source which emits at least 25 tons of lead per year or, in the case of certain specified lead industrial source categories, five tons per year.) The significant sources requiring review and evaluation were:

- Delco-Remy, Division of General Motors Corporation (New Brunswick)
- National Smelting of New Jersey, Inc. (Pedricktown)
- Federated Metals, Inc. (Newark)
- U.S. Metals Refining Co. (Carteret), and
- E.I. Dupont de Nemours & Co., Inc. (Deepwater)

In addition, the State identified the following two point sources of lead which, although not "significant," are considered to have the potential to emit greater than five tons of lead per year.

- Heubach, Inc. (Newark)
- Rollins Environmental Services, Inc. (Logan Township)

According to EPA regulations the State is not required to demonstrate attainment in the vicinity of these sources because they do not emit 25 or more tons per year of lead.

The seven sources just identified comprise all the point sources of lead in New Jersey. These sources have been (or will be) evaluated by the State according to the following procedure:

- A field investigation was conducted to identify fugitive emissions.
- The total lead emission rate was calculated using appropriate fugitive emission factors coupled with control efficiencies and operating parameters, and allowable stack emission rates contained in the source's operating permit.
- The source was modeled using EPA-approved dispersion modeling methods.
- If the modeling results predicted a violation of the ambient lead standard, stack testing was performed.
- The source was remodeled using the stack test results. If a violation was predicted using actual stack emission rates, then an air quality monitor was installed in the vicinity of the source to verify the modeling results.
- If the violation is verified by the monitoring results, then the State will take mitigating action, usually in the form of an administrative consent order containing an enforceable schedule under which the source causing the violation implements control measures to eliminate the contravention of the ambient standard.

Table 1 provides a summary of the status of the attainment demonstrations for all major lead point sources in the State. The following sections discuss th attainment demonstration for each source.

TABLE 1.—SUMMARY OF THE ATTAINMENT DEMONSTRATIONS PERFORMED FOR MAJOR POINT SOURCES OF LEAD IN NEW JERSEY

Source	Fugitive emissions found?	Modeled attainment?	Stack testing conducted?	Monitored attainment?	Compliance measures
Delco-Remy, New Brunswick	No	No	Yes	No	Consent order (if necessary-see discussion).
National Smelting, Pedricktown	Yes	Yes	Yes	Yes	Plant closed (Permits revoked).
Federated Metals, Newark	Yes	Yes	No	Not necessary	None necessary.
U.S. Metals, Carteret	Yes	Yes	Yes	Monitoring requested by EPA	Consent order.
Dupont, Deepwater	No	Yes (marginal)	Yes	Monitoring requested by EPA	None necessary.
Heubach, Newark	Yes	Inconclusive	Yes	Monitoring to be conducted	Consent order (if necessary-see discussion).
Rollins Env. Services, Logan Township	No	Yes	Yes	Not necessary	None necessary.

Delco-Remy, Division of General Motors Corporation, New Brunswick

In its December 29, 1983 notice of proposed rulemaking, EPA found that New Jersey's demonstration of attainment in the vicinity of Delco-Remy (lead-acid storage battery manufacturer and secondary lead smelter) was inconclusive. This was because the emission rates used in the modeling of this source had not been verified by stack testing.

In its supplemental submittal, the State provided the results of revised dispersion modeling of Delco-Remy's lead emissions. Emission inputs to the model were based on updated lead emission data supplied by the company when applying for a revised permit. The revised modeling predicted a marginal violation of the ambient standard (1.6 $\mu g/m^3$ compared to a standard of 1.5 $\mu g/m^3$). However, EPA considers the analysis inconclusive due the uncertainty in the lead emission rates employed in the model. These emission estimates are therefore currently being verified by stack testing.

Following the revised modeling a high volume air sampler (ambient monitor) was sited by the State near the location of the modeled violation. Contraventions of the quarterly lead standard have been measured by this monitor. However, it cannot be concluded that the measured violation is solely attributable to the emissions of Delco-Remy.

Given the inconclusive nature of the modeling analysis, and considering the potential impacts of nearby industrial facilities and rail lines, further investigation appears called for. In cases, such as Delco-Remy, where an ambient violation is measured even though the source has "reasonably available control technology" (RACT) applied to all process and non-process emission points, EPA guidelines allow "RACT plus studies" approach to lead SIP development. Under this approach, in lieu of an attainment demonstration a State may submit as part of its SIP a workplan for investigating and ultimately correcting the violation. EPA judges the adequacy of such workplans based on the following criteria:

• A justification, which has been verified by EPA, that the level of emission controls in place constitutes RACT.

• A detailed study protocol to identify individual emission points which may be contributing to the violation, potential measures for their further control, and a legally enforceable schedule for the implementation of the control measures.

• Establishment of an air quality monitoring network around the source(s) suspected of contributing to the violation of the lead standard.

New Jersey has employed the "RACT plus studies" approach in addressing the situation regarding Delco-Remy. As a part of its supplemental submittal the State provided a workplan for a special study of this facility and EPA has found that the workplan meets all of EPA's criteria. Phase III of this workplan describes a plan for requiring the installation of beyond-RACT control measures if they are found to be necessary in order to prevent violations of the ambient lead standard. The schedule calls for such control measures to be selected by January 1986, and appropriate actions based on existing State legal authority to be implemented by March, 1986.

In a separate part of its supplemental submittal, the State included a description of how the New Jersey Administrative Code, Title 7, Chapter 27, Subchapter 6, "Control and Prohibition of Particles from Manufacturing Processes" (N.J.A.C. 7:27–6) could be revised in order to incorporate maximum allowable emission rates for lead. The State has not committed to making these revisions to Subchapter 6 for controlling lead emissions in the State. Instead, New Jersey has chosen to rely on the authority of other portions of N.J.A.C. 7:27, including Subchapter 5, "Prohibition of Air Pollution," Subchapter 8, "Permits and Certificates," Subchapter 13, "Ambient Air Quality Standards," and Subchapter 18, "Control and Prohibition of Air Pollution from New or Altered Sources Affecting Ambient Air Quality in Nonattainment Areas." However, if it is determined that any control measure required under Phase III of the "RACT plus studies" workplan requires supplemental regulatory authority by means of specific lead emission limitations, the State should revise Subchapter 6 or develop and adopt other regulations, as appropriate, to incorporate such limitations.

EPA finds that the "RACT plus studies" workplan for Delco-Remy is adequate and approvable as an element of the SIP, provided that the State submits, as it has agreed to, a plan for expeditiously adopting new authorities within the time frame of Phase III of the "RACT plus studies" workplan, in case implementation of the "RACT plus studies" workplan indicates that such authorities are necessary.

National Smelting of New Jersey, Inc., Pedricktown

In its December 29, 1983 notice of proposed rulemaking, EPA found that the demonstration of attainment for National Smelting (lead smelter) was incomplete and inconclusive since the State had not completed the development of necessary control measures. In addition, a nearby monitor had measured repeated violations of the lead standards. Since the time of EPA's December 29, 1983 notice of proposed rulemaking, National Smelting of New Jersey has permanently ceased operations, and all of the company's operating permits have been revoked by the State. The only remaining source is one of fugitive emissions of dust from open slag storage piles at the abandoned plant site.

In its supplemental submittal, the State presented dispersion modeling data which showed no predicted violations of the ambient lead standard from the slag pile emissions. The entire plant site, including the slag storage piles, has been placed on a priority list for cleanup under the provisions of the federal Comprehensive Emergency Response, Compensation, and Liability Act. EPA finds this demonstration of attainment at the former National Smelting of New Jersey site approvable.

Federated Metals Inc., Newark

An attainment demonstration for Federated Metals (secondary lead smelter) was included in the October 6, 1983 draft SIP evaluated by EPA in its December 29, 1983 notice of proposed rulemaking. The October 1983 draft SIP presented results of a modeling analysis of Federated Metals Inc. (then known as ASARCO, Inc.) which predicted no violations of the ambient standard as a result of the facility's lead emissions. In performing its analysis, the State did not consider the potential impact of fugitive emissions from the facility.

EPA requested in its December 29, 1983 notice of proposed rulemaking that the State revise its attainment demonstration to include fugitive emissions in the calculation of total lead emissions from the facility. The State, in its supplemental submittal, presented the results of revised dispersion modeling of Federated Metal's lead emissions, including fugitive emission estimates based on visual observation and the use of emission factors.

The updated modeling, which took into account fugitive and stack emissions from the facility's reverberatory furnaces, predicts no violation of the ambient standard in the vicinity of the facility. Furthermore, in a June 8, 1984 letter from the State to EPA it was indicated that these furnaces have been shut down and taken out of service. While the conclusion of the attainment demonstration for Federated Metals is not affected by this information, in order to clarify the status of the Federated Metals' furnaces, the State must either revoke the operating permits for this equipment and submit evidence of such revocation to EPA prior to EPA's final approval of the lead SIP, or alternatively, submit more definitive information on the current and projected operating status of the furnaces.

Therefore, EPA finds the attainment demonstration for the Federated Metals Inc. facility to be approvable, provided that the State clarifies the operating status of the reverberatory furnaces, as it has agreed to do.

U.S. Metals Refining Co., Carteret

Modeling of the U.S. Metals facility (secondary copper smelter) without including the effect of fugitive emission controls showed a violation of the ambient standard. However, modeling of this facility was also performed under the assumption that fugitive emissions would be controlled, as a result of a State administrative consent order applicable to this facility. This order requires a 90 percent reduction in fugitive emissions, and has been made a part of the SIP. Modeling of U.S. Metals' lead emissions, incorporating the projected 90 percent reduction in fugitive emissions, predicts attainment of the standard in the vicinity of the facility.

However, in view of the uncertainty in the quantification of the expected reduction in fugitive emissions, EPA believes that site-specific ambient monitoring in the vicinity of the U.S. Metals facility is essential in order to confirm that execution of the control program required by the consent order will result in compliance with the ambient standard. Included in the State's supplemental information was a draft protocol for an ambient air sampling program for lead in the vicinity

APPENDIX F

ECOLOGICAL TOXICITY ASSESSMENT

SECTION 6 - TOXICITY ASSESSMENT

6.01 Literature Descriptions of Effects and Effective Concentrations

As discussed below, due to chronic exposures to lead residues, aquatic and benthic organisms are considered to be the most sensitive receptors of site related lead. Residues in surface water and sediment are measurable indicators of ecological effects.

6.01.01 Toxicity of Lead to Vegetation

The effects of lead on vegetation vary significantly between species. Review of studies found that only a small portion of lead is taken up by plants. Ward et al. (1977) found that the lead content of plants was approximately 10% of the lead content of the soil. Ward et al. (1977) also found equal values of lead in all organs of rye grass and white clover (or even a little lower) in 10,000 mg/kg lead and 1000 mg/kg substrates. This indicates that a limiting value for lead in plant organs exists. This same study also found the germination of seeds to decrease with increased lead concentration in the soil. A 20% and 10% reduction in germination was found to occur at 1000 mg/kg lead in the soil for rye grass and white clover respectively [Ward et al. 1977].

Extensive review of studies was performed to determine toxic levels of lead to vegetative species that occur within the study area. The information provided by the data search illustrated the wide range of lead tolerance and effects on vegetation. The levels of toxicity to vegetative species documented as present within the study area were not found.

Effects have been found in low lead soil concentrations (12 to 312 mg/kg in soil) in some plant species [Eisler, 1988]. Ward et al. (1977) found that lead concentration in soils of greater than 500 mg/kg reduced plant height by half for rye grass and white clover. In a similar study, Judel and Stelte (1977) found that at 500 mg/kg lead in the substrate, uptake into plants occurred, although no symptoms of toxicity and yield reduction were found in three vegetable plants (radish, carrots, and spinach). The vegetative species utilized in the above-mentioned studies do not occur within the study area. These studies show the variation of effects of lead to different vegetative species.

Although uptake of lead varies widely among different species of plants, damage is usually negligible with elevated lead content [Eisler, 1988]. Several studies have documented that some plant species are lead tolerant and that the degree of lead tolerance in plants is related to the lead content of the soil [Atkins et al., 1982; Hutchinson et al., 1987]. A similar study by Holl and Hampp (1975) found that some genetically fixed resistant species grow in soils with up to 10,000 mg/kg lead. Due to the length of time that soil lead concentrations have been elevated from previous smelting operations, influx of lead tolerant species in portions of the study area with the highest levels of lead in soils is probable. The effects of lead to lead tolerant plants are not evident at lower lead concentrations due to their tolerance.

In conclusion, review of the literature suggests that some species may be affected in soil lead concentrations of 500 mg/kg or greater and that germination of seeds may be effected in lead soil concentrations of 1000 mg/kg or greater. The biological impact to vegetation from the concentration of lead in the soil is variable due to the species of the plant, characteristics of the soil, the season, and the presence of other metals and substances in the soil. Vegetation observed in the wetland areas of the site did not demonstrate differences in type or size which could be attributed to the differences in soil lead content.

6.01.02 Toxicity of Lead to Terrestrial Invertebrates

Tolerance of elevated lead levels by some invertebrates has been found to occur. A soil litter lead concentration of 12,800 mg/kg, as lead oxide, was given by Eisler (1988) as being "similar to the amounts of reportedly associated with reductions in natural population of decomposers, such as fungi, earthworms, and arthropods." Reduced populations of invertebrates may disrupt nutrient cycling, contribute to food chain contamination, and decrease the amount of available invertebrates for food to other wildlife [Eisler, 1988].

6.01.03 Toxicity of Lead to Terrestrial Vertebrates

In his synoptic review, Eisler (1988) compiled many studies on the effects of lead to terrestrial vertebrates. 800 mg/l and 1000 mg/l of lead was given to mice in drinking water for 11 weeks and 9 months, respectively. Effects to litter size, survival of pups and decreased birth weights were observed at 800 mg Pb/l although at 1000 mg Pb/l no effects to survival or fertility were noted. In lambs fed diets containing 400 mg Pb/kg, with adequate minerals added to the diet, some weight loss was observed in 10 months, but otherwise the lambs were normal. Another study found varying effects of lead in drinking water in rats. Although disturbed sleeping patterns were observed at 1.5 mg Pb/l, toxic effects were not noted at 4000 mg Pb/kg in drinking water administered for 130 days.

In his study, Eisler (1988) states that biomagnification of lead is uncommon in terrestrial communities. Interpretation of the available data shows that consumption of vegetation growing in soil containing lead is not detrimental to terrestrial wildlife.

6.01.04 Toxicity of Lead to Avifauna

Exposure pathways of lead to avifauna is discussed previously in Section 5. In his synoptic review, Eisler (1988) stated that clinical lead poisoning was unlikely to occur to avifauna from ingestion of food containing biologically incorporated lead, although the lead burden of carnivorous birds would increase. Although some rooted aquatic plants can accumulate up to 67 mg Pb/kg dry weight, Eisler (1988) states that this concentration of lead is not considered hazardous to waterfowl feeding on the plants.

6.01.05 Toxicity of Lead to Aquatic Organisms

The USEPA [1987], developed ambient water quality criteria for the protection of aquatic life from lead. Freshwater organisms have been tested for acute and chronic sensitivities. Acute toxicity decreased as the hardness of water increased. At 50 mg/l as $CaCO_3$ of total hardness 10 species were tested for acute sensitivity. The lowest observed effect level ranged from 0.1425 mg/l for an amphipod to 235 mg/l for a midge. Chronic testing was conducted on two fish and two invertebrate species. The chronic toxicity also was affected by hardness. The lowest observed effect level in soft water was 0.01226 mg/l for a cladoceran while in hard water the value was 0.1281 mg/l for the same test organism. Acute to chronic ratios calculated for these species ranged from 18 to 62.

Based on the results of the testing, the USEPA established the ambient water quality criteria for lead based on the total hardness of the water. Table S-5 presents the calculated AWQC - acute and chronic for various hardness concentrations observed at the site.

5.01.06 Toxicity of Lead to Benthic Organisms

An extensive literature review was performed to determine the effects of lead to benthic organisms. Abstracts, journal articles, reports and books were reviewed. A listing of sources is provided in Attachment S-5.

Several sources concur on the lack of correlation between sediment lead concentrations and tissue lead concentrations following uptake by aquatic organisms (Hannan et al., 1976; Ahlf, 1985; Finerty et al., 1990). These authors found that locations with the highest levels of metal (lead) residues in the sediments were not necessarily the locations where aquatic species had the highest levels in their tissues (Finerty et al., 1990). In fact, although some sediment samples were toxic according to an algal assay, there was almost no correlation between the concentration of lead in the alga cells and those in the sediment samples (Hannan et al., 1976). Based on these studies, it appears that data obtained from tissue sampling of aquatic inhabitants of the study area would not yield useful, directly applicable, nor (in the opinion of the referenced authors) correlatable information on the actual relationship between lead-in-sediment concentrations, and potential adverse biological impacts resulting from uptake of such heavy metals.

Information directly relating stream sediment concentrations of lead (as mg/kg) to toxicity criteria (either lethal or sub-lethal effects) was limited. Several authors echoed the difficulty in determining sediment quality criteria, due to variables such as dissolved and particulate-bound fractions (partitioning), water hardness and organism uptake mechanisms. Of significance among the many variables, the relative toxicity of lead in sediment to aquatic organisms is apparently related to both combined heavy metal effects and pH. According to Starodub, the toxicity of metals to algal growth was enhanced at acidic pH. Combined toxicity of copper, zinc and lead was significantly greater at pH 4.5 than at pH 8.5 or pH 6.5. Synergistic effects between the three metals towards algal growth increased at low pH (Starodub et al., 1987).

Kalmaz discusses the toxicity and ecological significance of lead and other trace elements in the aquatic environment (Kalmaz, 1980). Kalmaz also notes the difficulty in accurately characterizing trace elements in the aquatic ecosystem due to their various forms of chemical and physical states, solubility, adsorption capability, particle size, reactivity with other organic and inorganic compounds and complex formation. The writer also acknowledges the growing contribution of man's typical activities in impacting the amount of trace elements in the ecosystem. However, no direct numerical correlation between sediment concentrations and toxicological impacts is presented.

To address the variables related to chemical and physical characteristics, Chapman (1986) pursued a triad approach, combining sediment chemistry with toxicological data derived directly from the sediments (i.e., sediment bioassays and in-situ studies) to develop the necessary sediment quality criteria. Chapman's study was conducted in Puget Sound, Washington. In a further study, Chapman et al. (1987) compared four independent approaches to establishing sediment quality criteria, including his study just described.

The concentrations of selected potentially toxic chemicals (including lead) in marine, estuarine and freshwater sediments have been quantified annually by NOAA in the NS&T Program since 1984. Sediment samples from over 200 sites have been collected and analyzed; the data have been used in characterizing the chemical conditions at the sampling sites. In selected geographic areas, measures of biological (toxic) effects have been performed to indicate the significance of the sediment contamination. The intended use of the data is to assess the potential for adverse biological effects occurring due to exposure of biota to toxicants in the sampled sediments, as part of an effort to determine effects-based sediment quality criteria.

NOAA's program utilized data from several sources to identify concentrations for substances where biological effects have been observed. NOAA reported six bioassays conducted on Puget Sound and San Francisco Bay. The results were as follows:

	Lowest Observed Effect Concentration
Rhepoxynius abronius amphipod bioassasy - 1986	660 mg/kg
Crassosprea gigas oyster larvae bioassay - 1986	660 mg/kg
Rhepoxynius abronius amphipod bioassay - 1988	660 mg/kg
Crassosprea gigas oyster larvae bioassay - 1987	660 mg/kg
Bivalve larvae bioassay	140 mg/kg
Rhepoxynius abronius amphipod bioassay	120 mg/kg

Additional information was presented based on the presence of lead and other contaminants in sediment with observed effects. This was defined as the co-occurrence approach. The range reported using the co-occurrence approach ranged from 26.6 mg/kg to 1613 mg/kg. Other substances present in the sediment tested will affect biological responses and those observed effects may have nothing to do with the lead concentrations. The probability of this misinterpretation increases as concentrations approach typical background concentrations. Attachment S-5 includes Table B-6 which lists studies reviewed by NOAA for the program. Also included in Attachment S-5 is Table 12 which presents the values used for ranking sites. It is clear that all of the locations at concentrations of less than 120 mg/kg were co-occurrence citations and thus, potentially affected by other parameters. Table B-6 also includes studies where sediment lead concentrations as high as 276.9 mg/kg demonstrated no effect. Therefore, the co-occurrence approach may be useful in ranking sites for subsequent studies but is not valid for determining toxic concentrations of one of the substances present and thus establishing cleanup criteria.

Studies conducted on sediment samples in the Chesapeake Bay were reported in Alden, et.al., 1991. The results presented in reproductions of Tables 23 through 25 in Attachment S-5, indicate no apparent effects on Palaemonetes pugio and Mytilus edulis at lead concentrations as high as 300 mg/kg. For the seven samples which ranged in lead concentration from 97 to 300 mg/kg, the ratio of observed toxicity to the reference area averaged less than unity indicating no observed effect. It is important to note that these sediment samples also contained significant concentrations of other metals and organics. The difficulty of evaluating a specific substance's apparent effects threshold in sediment samples with numerous contaminants present was a conclusion of the Alden, et.al. study. Extensive review of many studies of the toxic effects of lead to aquatic organisms by Eisler (1988) found that lead accumulates in biota from water, but food chain transfer of lead is not evident.

In summary, interpretation of the data on sediment toxicity resulting from lead is complicated by numerous factors. The bioavailability, presence of other substances, and the salinity of the water may all affect the biological impact. A detailed review of the NOAA document demonstrates that the method employed to develop the ER-M and ER-L are not valid for establishing clean-up criteria. This was specifically stated in the NOAA document (page 1). A review of the literature suggests that sediment lead concentrations below 100 mg/kg are unlikely to affect the biota. Sediment lead concentrations in excess of 1000 mg/kg likely affect species diversity and if widely distributed could affect a specific aquatic system. Concentrations in the range of 100 to 1000 mg/kg are more subject to localized variables and whether adverse impacts are evident would require site-specific study.

6.02 Review of Toxicity Based Criteria and Standards

New Jersey surface water quality standard for the East and West Stream for waters is a lead concentration below 0.050 mg/l based on protection of human health.

The USEPA has developed ambient water quality criteria for lead in freshwater systems. Because the literature suggests that toxicity is a function of the hardness of the water, the criteria is a value calculated from the hardness of the water. The total hardness measured in the East Stream south of Route 130 ranged from 56 to 73 mg/l as $CaCO_3$; resulting in an acute AWQC for lead in the range of 0.039 to 0.055 mg/l. The chronic AWQC for this stream segment is calculated at approximately 0.002 mg/l. The West Stream south of Route 130 demonstrated total hardness ranging from 55 to 69; resulting in AWQC in the range of 0.038 to 0.051 mg/l. The chronic AWQC for this stream segment is also calculated to be approximately 0.002 mg/l. North of Route 130, the hardness increases substantially yielding an average hardness of 180 mg/l as $CaCO_3$. The AWQC acute for this stream segment is 0.173 mg/l, while the chronic AWQC is calculated to be 0.007 mg/l. The dramatic increase in hardness north of Route 130 may be related to the Corps of Engineers dredge spoil areas adjacent to the stream.

No toxicity based criteria or standards are available for lead in sediments or soils.

SECTION 7 - RISK CHARACTERIZATION

7.01 Observed Adverse Effects in the Assessment Area

At the time of the site reconnaissance in November 1990, no effects to the ecology potentially attributable to site residues were observed outside of the site boundaries (See Figure S- . Much of the area within the site boundaries is paved, stone covered landfill, dirt roadway, stru ures, or subject to recent construction activities. No readily observed ecological effects were dentified during the field investigation of the site during November 1990.

7.02 Estimated Adverse Effects in the Assessment Area

A number of viable exposure scenarios exist that make it very likely that organisms associated with the study area are exposed to lead residues. The probability of effects with respect to identified exposure scenarios is discussed as follows:

Vegetation: Soil lead concentrations in the study area vary from background of 10-20 mg/kg; to 12700 mg/kg. All areas where the soil lead concentrations exceeded 1000 mg/kg are within the boundaries of the NSNT site or in an isolated area near Browning Ferris Industries property. Therefore, vegetation growing in over 90% of the study area are not anticipated to be at risk from lead exposure.

Extensive field observations during the wetland delineation did not reveal biological impacts to lead exposure. No significant difference in plant height was found to exist in portions of the site variable soil lead concentrations. In the forested portions of the study area, no evidence of stunted growth was observed. In the herbaceous portions, determination of the height of the vegetation was difficult due to mowing operations. No evidence of stunted growth was observed in the non-forested portions of the site which are not mowed.

Terrestrial Invertebrates: Elevated concentrations of lead outside of the manufacturing area have been shown by soils testing to be limited to the top 3 to 6 inches of soil. The range of soil lead from background to 12700 mg/kg was reported. Epidermal and ingested exposure to lead is anticipated to be significant to invertebrates that burrow in the top 3 to 6 inches of soil where the highest concentrations of lead have been identified. The effects of lead residues from the site are not quantifiable, however, Eisler (1988) did indicate that detrital lead concentrations in excess of 12800 mg/kg could adversely affect invertebrates such as earthworms.

Terrestrial Vertebrates: Consumption of biota from areas with elevated levels of lead within the soils was not found to have detrimental impacts to terrestrial vertebrates (See Section 6.01). As previously stated, vegetation has the potential to uptake available lead, however, lead does not significantly biomagnify in vegetation or in organisms as a result of consumption of exposed biota [Eisler, 1988]. Therefore, should exposures of lead occur to organisms in these communities, they can be expected to be consistent with ambient concentrations.

Consumption of biota on the site, for most organisms, will likely occur on a transient basis. For example, the presence of white tailed deer has been confirmed on the site and deer are likely exposed to site residues through consumption of exposed vegetation. However, deer will browse vegetation outside the range of where lead concentrations occur as well. Given the range of deer and the small amount of lead uptake by plants, the areas in which soil lead concentrations are elevated would be expected to result in insignificant lead accumulation to deer. Carnivores identified in the study area are expected to have a range comparable to the deer and thus, low probability of health effects.

Avifauna: As discussed in Section 3.04, species of avifauna, both aquatic and non-aquatic, utilize the study area. Exposure of lead in non-aquatic avifaunal species is not anticipated to be significant due to the transient nature of birds which influences the quantity of food and water obtained within the study area. The Stream vegetation and organisms which populate the stream are expected to contain lead concentrations above background. Lead exposure to aquatic avifauna, such as the great blue heron, feeding in the West Stream is expected. However, the fresh water wetlands within a radius of ten miles are substantial, so the percentage of feeding time in the West Stream may not be significant and this exposes little risk to this target species.

Aquatic Organisms: As discussed in Section 3.04, the East and West Streams support aquatic populations. Organisms that inhabit these streams are chronically exposed to lead from the site. Because of this chronic exposure, aquatic organisms are examined as a sensitive indicator of lead.

The ratio of the observed lead concentration to the AWQC is indicative of the probability and magnitude of effect. A value less than one would suggest no effect. The higher the value above 1, the higher the probability of an effect. Figure S-14 presents the ratio of the lead concentration to the AWQC - acute values. The data suggests that the potential for acute effect would be limited to the West Stream between Pennsgrove-Pedricktown Road and Route 130. All other samples had a lead concentration below the AWQC-Acute value. The probability of a chronic effect is higher, as presented in Table S-5 and Figure S-12. The water quality in the West Stream south of Route 130 exceeds AWQC by over an order of magnitude suggesting a high probability of chronic effects on aquatic organisms. The water quality extending on to the military reservation exceeds the AWQC chronic by a factor of approximately 4, however, water quality improves to meet AWQC chronic concentrations for lead approximately 5,000 feet upstream of the Delaware River.

Benthic Organisms: Figure S-13 summarizes surface sediment results from the East Stream, West Stream and Corps of Engineers area. Mean concentrations are used rather than point concentrations to provide an overview of the magnitude of potential effects in various stream segments.

The potential for biological impact in the West Stream between Pennsgrove-Pedricktown Road and Route 130 is quite high as the geometric mean lead concentration reported upstream and downstream of the railroad crossing are 6,970 mg/kg and 1,340 mg/kg, respectively. Conversely, the potential for biological effects in the drainage channel on the military reservation near its confluence with the Delaware River is negligible as is the possibility in portions of the East Stream.

The other stream segments presented in Figure S-13 contain mean lead concentrations which may or may not have biological effects because of the substantially lower concentrations of lead present and its uneven distribution in these areas.

APPENDIX G

SCREENING OF REMEDIAL TECHNOLOGIES - SOIL

APPENDIX G
SCREENING OF REMEDIAL TECHNOLOGIES - SOIL

1. Institutional Technologies

The following institutional technologies could be implemented at the Site:

Access Restrictions: Access restrictions are utilized to limit the risk of direct contact with soil not meeting response objectives by the general public. Several forms of access restrictions are available.

Fencing: Fencing provides a cost-effective method of physically preventing access to a site. Periodic inspection of fence integrity, however is required. This option will be retained for further evaluation.

Deed Restrictions: The future use of a site may be restricted to protect human health and the environment. This process option will be retained for further evaluation.

Monitoring: An inactive site can be monitored to reveal changes in site conditions. This information can be used to re-evaluate the risk associated with a site. Monitoring will be retained for further evaluation.

2. Containment Technologies

The objective of the containment general response is to limit the mobility of waste constituents and to prevent inadvertent direct contact with soil not meeting response objectives. Several remedial technologies and process options are available to implement this general response:

Vegetative Cover: This cover would prevent direct contact with soil containing lead. It would consist of six inches of clean soil placed directly on top of contaminated soil. A layer of grass would be added to the top of the clean soil to prevent erosion. This process option will be retained for further consideration.

Cap: Capping could be effective in limiting the spread of contaminated soil and preventing inadvertent direct contact with contaminated soil by the public. Unlike a

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vegetative cover, capping would provide additional protection by forming an impermeable barrier to limit stormwater infiltration. The following process option is evaluated:

Multi-Media: Multi-media caps typically consist of a low permeability soil layer, a root zone, a layer of topsoil, and a vegetative cover. Alternatively, a geomembrane may also be employed.~~substituted for the clay layer. Since the soil is not hazardous, this level of containment is not necessary.~~ A multi-media cap would, however, provide an additional level of protection with respect to the prevention of human contact. Therefore, this process option will be retained for further consideration.

Landfill: Landfilling can provide a greater degree of waste isolation than capping, but is more expensive. Two basic process options are available:

On-Site Landfill: On-site landfills are utilized when the site location and conditions, and the nature of the waste materials, are appropriate. Landfills typically consist of a primary and secondary liner which completely underlie the waste material, a primary and secondary leachate collection system, and a cap. A wide variety of natural and synthetic materials may be used for one or both of the liners; a common approach is to use a synthetic liner for the primary liner and compacted clay for the secondary liner. An alternative system would be a double composite liner. In this system, both the primary and secondary liner consists of a low permeability soil layer and a synthetic geomembrane (4 liners total). Leachate collection systems minimize hydraulic loading on the liner. The State of New Jersey Administrative Code (NJAC) Section 7:26 describes the requirements for constructing a secondary containment landfill in the State of New Jersey. The requirements include construction such that the bottom of the liner is at least five feet above seasonally high groundwater, construction of a liner system at least five feet thick, and maintaining a buffer of at least 300 feet from the top of the landfill to the property line where groundwater flow velocity is at least 1 foot/day.

Seasonal high groundwater levels, groundwater flow velocities and the quantity of soils at the NL Industries, Inc. site are such that a secondary containment landfill could not be adequately constructed within the property limits. Therefore, this alternative is not retained for further consideration.

Off-Site Landfill: Containment in an established landfill could be a feasible remedial alternative. The costs associated with off-site transportation, however, could be significant, depending on the proximity of the landfill to the Site. For soil that is not a hazardous waste, disposal in an industrial or municipal landfill may be appropriate as described below.

Municipal Landfill: According to the "Management of Excavated Soils Document" (developed by the NJDEPE Soil Reuse Committee), soil that is not a hazardous waste and has lead concentrations above 100 ppm is classified as non-hazardous waste and is called ID 27 waste. Mr. Mark Searfoss, an environmental engineer from the New Jersey Department of Environmental Protection and Energy (NJDEPE), was contacted concerning potential municipal disposal sites for lead-contaminated soil that is classified as an ID 27 waste. From his recommendation, two landfills were identified to take ID 27 waste:

Pennsauken Landfill: Mr. Pat Malone was contacted at the Pennsauken Solid Waste Management Authority (PSWMA) in Camden County. He stated that the waste classified as ID-27 by NJDEPE was acceptable and would cost $66.06/ton for disposal. The landfill, having a double composite Subtitle D liner/leachate collection system, is located in Pennsauken, NJ (Camden County) approximately 1 mile east of Philadelphia, PA. This process option will be retained for further evaluation.

Salem County Utilities Authority: A representative from the Salem County Landfill stated that the disposal cost for ID 27 soil is $64.71/ton. This landfill has a Hypalon (similar to HDPE) liner with three feet of compacted clay underneath. Under the clay liner is a 40-foot uncompacted clay layer. The landfill is in Alloway, NJ (Salem County).

Pennsylvania Landfills: A representative from the Bureau of Waste Management was contacted and stated that each region in Pennsylvania determines what contaminant levels they permit in their landfills. For all regions, solid waste is classified as either municipal, residual, or hazardous. Contaminated soil from an industrial site is classified as residual waste. In order to determine if the waste is acceptable at a particular landfill, a Module 1 Application must be submitted by that landfill to the Bureau of Waste Management Regional Office. Basically, a Module 1 Application includes analytical data from the generator of the waste that characterizes the waste and ensures it is not classified as hazardous. The Module 1 Application process may take up to 6 months or perhaps longer. Three landfills were identified that might qualify to take the NL Pedricktown soil through the Module 1 process: Pottstown Landfill, Grand Central Sanitary Landfill, and Empire Landfill. The cost for disposal at these landfills ranges from $4 .0 to $53 ton.

Industrial Landfill: A representative from Chambers Development Company, . was contacted to determine the criteria for disposal in one of their landfills. mbers currently operates five landfills in Pennsylvania. The representative, however, gested disposal in their Virginia facility due to state-of-the-art landfill features at that site. This chemical waste landfill located in Charles City County, Virginia and accepts non-hazardous special wastes. The capacity of the landfill is 38 million cubic yards. The landfill has two 80-mil HDPE synthetic liners and a one-foot recompacted clay liner. There also exists a primary and secondary leachate collection system. The cost for disposal and hauling is approximately $67/ton provided the soil meets the criteria on the application process. Required sampling and analysis include a TCLP for metals and certification that the waste is not classified as hazardous in the state of generation.

Chambers Waste Systems of Virginia, Inc. anticipates constructing another chemical waste landfill in Amelia County, Virginia. This landfill will be similar in design to the existing landfill and is scheduled to open in 1992. Both landfills have access to rail services and will be retained for further consideration.

3. Treatment Technologies

There are many technologies available for the remediation of soils containing lead. Some technologies have been demonstrated as being effective based on bench-scale, pilot-scale, and/or full-scale studies. Some have been commercially available for many years. Others are still under development. Two ic classes of remediation that will be examined are: physical/chemical treatment and thermal treatment. Since biological treatment has not been demonstrated as being effective for metals removal from soil, it will not be dis ssed. The technologies described are screened for further consideration bas on implementability, effectiveness, and cost.

Solvent Extraction Processes

Solvent extraction is one of many treatment technologies being investigated by EPA. Cleaning excavated soils using extraction agents shows promise for being applicable to almost any contaminant (Raghavan, et.al., 1989). Bench-scale and pilot-scale testing has been performed on soil containing metals.

Solvent extraction is a process that separates contaminants from soil particles using a liquid washing solution. There are two mechanisms that occur during the use of this technology:

1) Volume reduction of the soil to be treated and/or disposed. Most contaminants are attached to fine soil particles (e.g., silt, humus, and clay); soil washing separates the smaller particles from the larger particles.
2) Contaminant transfer from the soil medium to a liquid solvent medium, such as water. Contaminants in an aqueous medium are usually easier to concentrate and treat than those in soil.

Most solvent extraction technologies utilize one or both of these mechanisms. Four process options are described below:

Soil Washing: Soil washing utilizes a washing solution (such as water, surfactants, chelating agents, and/or acidic solutions) to achieve particle size separation and to extract contaminants from soil. The washing agent is selected based on several factors, two of which are the contaminant type and the soil size particle distribution (USEPA, 1991a). The washing solution and contaminated soil are mixed together, agitated through mechanical mixing, and separated again. Chelating agents chemically react with metal ions and enhance their solubility. Acid or alkaline solutions mobilize, neutralize, or destroy contaminants (Raghavan, et. al., 1989).

The main advantages of soil washing is that the volume of the contaminant mass is reduced through physical separation. One major disadvantage is that soil washing is still in the bench-scale/pilot-scale development stage. A second disadvantage is that soils which are high in clay, silt, and/or humic material have been difficult to treat. Also, for each site (and each varying soil type at each site), bench and laboratory-scale treatability tests would be required to determine the type of washing solution, optimum concentration, optimum reaction time, potential methods of regeneration and other wastewater treatment requirements. Furthermore, residuals from soil washing require treatment before disposal. Residuals include the wash solution and the fines. Treatment for aqueous wastes may include chemical precipitation/flocculation, adsorption onto activated carbon, or ion exchange and filtration. Treatment for fines may include solidification/stabilization or other processes. The cost of secondary treatment must be considered when evaluating soil washing processes (USEPA, 1991a). In addition, the effectiveness of treatment is highly dependent on particle size. Fine particles have a high adsorption capacity for contaminants and can be difficult to remove from the washing fluid. Wash solutions must also be tailored to the site. From pilot studies, it has been found that it is both difficult and costly to recover chelating agents (USEPA, 1991a).

Soil washing has not been applied to many lead battery recycling sites. From data from the two sites in which it has been applied there has been mixed success (Lee's Farm in Woodville, Wisconsin and the ILCO Site in Leeds, Alabama). Both sites used EDTA in their processes as the chelating agent. Although both sites indicated that the EDTA could reduce the lead concentration (e.g., at ILCO, lead concentrations dropped from 47,000 to 1300 ppm), material handling problems included fine particles clogging filters and excessive suspended solids loading to the EDTA/lead recovery system (USEPA, 1991c). A study conducted by PEI Associates determined that the soil at NL Pedricktown is slightly carbonate with the primary minerals being quartz and calcite ($CaCO_3$). The presence of calcite indicates the presence of a carbonated form of lead such as $PbCO_3$, $Pb_3(CO_3)_2(OH)_2$, or $Pb_4SO_4(CO_3)_2(OH)_2$. This study also indicated that at Pedricktown, the clay particles formed a thick coat around gravel particles during soil washing processes. This clay coating was unable to be removed during the soil washing (PEI Associates, 1990).

Based on USEPA direction, this technology will be retained for further consideration.

Hydro-Metallurgical Leaching: This process is based on the principles of hydro-metallurgy commonly used for the extraction of metals from ores. This process uses a hot aqueous caustic leach solution for the extraction of heavy metals from waste residues. This solution can be recovered and regenerated, which minimizes reagent costs and the volume of waste generated (USEPA, 1991c). This technology is still under development, therefore it is not retained for further consideration.

Electromembrane Reactor (EMR) Leaching: This electrowinning process uses EDTA as the chelating agent and lead recovery is achieved by electrodeposition. From treatability studies at two Superfund sites (Arcanum near Troy, Ohio, and Lee's Farm in Woodville, Wisconsin), the optimum EDTA/lead molar ratio was determined to be 1.5 to 2.0 for both soils. Even at optimum ratios, however, EDTA was not found to be effective in chelating metallic lead in the soils at both sites (USEPA, 1991c). This process option is therefore not retained for further evaluation.

U.S. Bureau of Mines Acid Leaching Process: The U.S. Bureau of Mines has met with success in conducting bench-scale studies of its process at three lead battery recycling sites (C & R Battery, VA; United Scrap Lead; and Arcanum, OH). This process converts lead sulfate and lead dioxide into lead carbonate. Lead carbonate, which is soluble in fluosilicic acid, can be separated from the soil. The lead is precipitated as lead sulfate by electrowinning and the acid solution is returned to the leaching process. The clean soil can be returned to the site and the lead sulfate (which may or may not require further treatment) can be sold. Some pretreatment may be required for the wash streams before discharge (USEPA, 1991a and USEPA, 1991c). Because the technology is still under development, and because the bench scale tests to date have been conducted on soils with a much lower lead concentration than those typically observed at Pedricktown, this process option will not be retained for further consideration.

Stabilization/Solidification

Solidification/stabilization (S/S) is a process designed to reduce the solubility, toxicity, and mobility of contaminants in soils or sludges. The process has been well developed and has proven to be highly effective for ex-situ applications (USEPA, 1991a). In order to describe process options, a brief definition of each of the above terms is given below (Freeman, 1989):

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Solidification - a process whereby binding agents are added to the waste to produce a solid. Binding reagents form mechanical and physical bonds in order to lock the waste within the binder material matrix. The process may or may not involve chemical bonding of the contaminant to the binder.

Stabilization - a process whereby stabilizing agents are added to waste to convert it into a more chemical-stable form. A chemical reaction takes place between the stabilizing agent and the waste in order to transform the waste to a new, less toxic compound or substance. This does not include biological processes. The term "fixation" is synonymous to stabilization.

Most processes use a combination of binders and stabilizers; therefore, solidification/stabilization is considered as one technology. Some reagents serve both as a binder and a stabilizer, depending on the contaminant.

The process operates as follows. Contaminated soil is mixed with an appropriate ratio of binder/stabilizer and water. The binding reagents absorb the free liquid in the matrix whereas the stabilizing agents may cause reaction with hydroxides and carbonates to form insoluble metal compounds. The material, once treated, usually solidifies into a monolithic block of high structural integrity, or into stabilized granular material with soil or clay characteristics. There are several binders and/or stabilizers available for S/S processes. These include: portland cement, lime-fly ash, thermoplastic binders (asphalt), and sorbents (e.g., activated carbon, clays, zeolites, and anhydrous sodium silicate) (USEPA, 1991a). Process options described later in this section use a number of these various binders.

S/S is highly implementable for treating lead-contaminated soils and sludges. It has been widely tested at many Superfund sites and has been described as a reliable treatment technology. Also, S/S has generally been less expensive than other treatment options. One major disadvantage of S/S processes is the volume increase in the material treated which can range from 10 to 100 percent (USEPA, 1991c). Another major concern is that little information is available about the long-term stability of treated waste (USEPA, 1991a).

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The soil at the facility is not expected to have characteristics of hazardous waste; therefore, treatment to reduce leachability is not required. Solidification/stabilization could be used, however, to reduce potential exposure through direct contact, and could reduce potential off-site migration of contaminated soils. The following solidification/stabilization agents are applicable:

Portland Cement is a solidifying agent with relatively low cost and high availability of mixing equipment. Drawbacks include a 100 % increase in weight and volume. In addition, most wastes do not chemically bind to the cement matrix.

HAZCON Solidification Process uses cement mixed with a patented non-toxic chemical called Chloranan. Chloranan neutralizes the inhibiting effects that organic contaminants normally have on the hydration of cement-based materials. Heavy metals were immobilized with leachate reductions in excess of a factor of 100 in many cases (USEPA, 1988). The cost is estimated to be $97 to $205/ton.

Solidtech, Inc. is a S/S process that uses a proprietary reagent and additives with pozzolanic materials such as fly ash, kiln dust, or cement in order to immobilize metals. From a pilot-scale study, this process demonstrated high effectiveness on immobilizing arsenic, lead, and zinc within soil samples (USEPA, 1991c).

Chemfix Process uses a silicate-based additive to treat both solid and liquid waste as a S/S technique. This process was specifically designed to process large quantities of toxic inorganic wastes in a short time due to high capacity equipment. The equipment can process up to 160 tons/day in an 8-hour day. The process was initially designed to treat liquid wastes and sludges but is now able to treat soils. The final material has characteristics similar to clay-like soil. The cost is estimated to be $73/ton of raw waste (USEPA, 1991b).

This technology will be retained for further consideration.

Tilling

Tilling can reduce surface concentrations of lead through homogenization. Lead at lower surface concentrations is less bioavailable However, tilling does not meet CERCLA goals of reducing toxicity, mobility or volume of contamination and is unacceptable to EPA. Therefore, this process option will not be retained for further consideration. However, tilling may be employed as a mechanism to be used with soil stabilization/solidification.

Thermal Treatment Processes

Thermal treatment processes include any technology that uses thermal energy in a controlled environment to reduce the volume, toxicity, or mobility of a contaminant. Five such processes include: flame reactors, electrokinetics, vitrification, plasma reactors, and cyclone furnace process. All five processes are under development by the SITE program. Thermal treatment reduces the leachability of metals in soil but does not reduce the concentration of lead in the soil. Therefore this technology could reduce the potential exposure through direct contact, and could reduce potential off-site migration of contaminated soils.

Flame Reactor: The Flame Reactor process is patented by Horsehead Resource Development Co., Inc. This flash smelting process is designed to treat granular solids, soil, flue dust, slag, and sludge containing heavy metals and/or organics. Wastes are introduced to a hot reducing gas (above 2000°C) produced from the combustion of solid or gaseous hydrocarbon fuels in oxygen-enriched air. The reactor produces non-leachable slag (glass-like in appearance) and metal-enriched oxide which can be recycled as fill material or road aggregate. The volume reduction of waste to slag depends on the chemical and physical properties of the waste.

This technology is being demonstrated as part of the Superfund Innovative Technology Evaluation (SITE) program. It has not, however, been widely tested at Superfund sites. The iron-rich aggregate formed from the molten slag contain metal contaminants that can be recovered as crude and as heavy metal oxide. The off-gases produced must be handled using air pollution controls (USEPA, 1991a). Since this process is still under development, it will not be retained for further consideration.

Electrokinetics: Electrokinetics can be used as an effective technology to remove heavy metals from both soil and ground water. The basis of this technology is the movement of ions, particles, and water under the influence of an electrical field. This process has

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been demonstrated both in the United States and Europe. The process operates as follows.

The phenomenon of electrokinetics occurs when a liquid migrates through a charged porous medium (e.g., soil) which is under the influence of a charged electric field. The charged medium usually holds a negative surface charge and is composed of clay, sand, or other mineral particles. Anodes and cathodes placed in wells are used to induce the electrical field. Cations within the soil will migrate toward the negatively-charged cathode within the extraction well. In the area between the cathode and anode, a concentration gradient is established causing the metal ions to diffuse from areas of low concentration to areas of high concentration. Site-specific factors will determine the spacing of wells containing the cathode and anode. The cathode and anode housing have separate circulation systems filled with different chemical solutions in which to capture the contaminants. Periodically, the solution is sent through a purification process (USEPA, 1991a). Since this process is still under development, it will not be retained for further consideration.

Vitrification: This process uses large electrodes that are driven deep into the soil to transfer an electric current through the soil. Heat from the current causes the soil to melt starting at the surface and traveling downward. Once this happens the soil is converted into a durable glass and wastes are pyrolyzed or crystallized. Escaping vapors are trapped in an above-ground negative pressure hood where they are treated. The residual vitrified mass is considered inert and impermeable.

This process was initially designed for treatment of low-level nuclear wastes but can be applied to other wastes, such as soils contaminated with metals. Advantages of vitrification include the lack of oxidation products, lack of air emissions, and reduced leachability of inorganic materials (e.g., heavy metals). One major disadvantage of this process is that it is highly energy-intensive (often requiring temperature up to 2500 °F) and therefore expensive. Also, volatile metals (e.g., arsenic, lead, and mercury) would be volatilized and may not be immobilized in the glass-like mass. This process is also still under development; therefore, this process will not be retained for further consideration.

Retech, Inc. Plasma Reactor: This is a thermal treatment unit that uses heat from a plasma torch to create a molten bath. Organic contaminants vaporize and react at very high temperatures to form innocuous products. Soil and other solids melt within the molten bath. The metals remain in this molten bath which cools into a non-leachable matrix. The Retech, Inc. Plasma Reactor is still being tested and is not ready for commercial application (USEPA, 1991c). Therefore, this technology will not be retained for further consideration.

<u>Babcock and Wilcox Co. Cyclone Furnace Process</u>: This thermal treatment process is designed to treat wastes containing organics and/or metals. The wastes are fed into a cyclone furnace which retains heavy metals in a non-leachable slag while vaporizing organics. The organics are then incinerated within the furnace. The treated soils resemble natural obsidian (volcanic glass), very similar to the final product of vitrification. This process, however, is still being developed by Babcock and Wilcox under the SITE Emerging Technologies Program (USEPA, 1991c). It will therefore not be retained for further consideration.

4. Removal Technologies

<u>Excavation</u>

There are many methods and various types of equipment that can be used to excavate soil. Site conditions do not warrant the use of special excavation equipment; standard construction procedures (and conformance to a site-specific Health and Safety Plan) would be utilized to remove soils not meeting the response objective. This process option will be retained for further consideration.

The technologies described in this appendix were evaluated based on information from previous studies and waste treatment manuals. All sources referenced are listed in the reference section at the conclusion of the main report.

APPENDIX H

SCREENING OF REMEDIAL TECHNOLOGIES - GROUND WATER

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1. Institutional Technologies

The following institutional actions could be implemented at the Site:

Access Restrictions: Access restrictions can be utilized to limit the risk of direct contact with contaminated ground water by the general public. Specifically, Deed Restrictions could be used to limit site and off-site ground water use. This process option will be retained for further evaluation.

Monitoring: Since the Site is inactive, monitoring can be used to reveal changes in Site conditions. This information can be used to re-evaluate the risk associated with the Site. Ground water monitoring will be retained for further evaluation.

2. Containment Technologies

With respect to ground water, the objective of the containment general response is to limit the mobility of waste constituents. The use of subsurface barriers to achieve this general response is evaluated.

Subsurface Barriers

In order to contain ground water, barriers can be installed to impede horizontal flow. Two types of subsurface barriers are slurry walls and grout curtains.

Slurry Walls: Slurry walls are the most common type of subsurface barrier. Although slurry walls may be constructed out of different materials, a common feature among them is that they are all constructed in a trench. In order to obtain a trench depth of 35 to 50 feet, an extended boom backhoe can be used. For trenches 100 feet and deeper, a clamshell is appropriate. The trench formed is then backfilled using a mixture of the excavated material and a water-bentonite slurry. Different slurries can be used to backfill the trench. The two most common types of slurry walls are soil-bentonite (SB) slurry walls and cement-bentonite (CB) slurry walls. The base of the wall is usually keyed into an impermeable confining layer (e.g., clay, silty clay, or rock). In many cases, a cap is used to seal off flow from the area. A slurry wall can be placed either upgradient of or encircled about the entire region of cc cern (O'Brien & Gere, 1988).

Grout Curtains: Anoth type of subsurface barriers is grout curtains (often called grout walls). Grout curtains are formed by pressure-injecting grout material into an unconsolidated medium. Injection points are formed in the unconsolidated medium usually arranged in a triple line. The grout material is first pumped into the primary injection points (the center line). After the grout material has had time to gel, more grout material is pumped into the seconda injection points. This secondary injection serves as a backup for the first. The purpose is to fill any gaps from the first injection (USEPA, 1985).

Grouting is rarely used for containing ground water flow in unconsolidated materials due to its cost. Grouting is primarily used for sealing voids in rock. The advantage f using grout curtains over other barriers is that they can be placed in a site i arious configurations. Also, grouting may be used to create horizontal barriers for sealing the bottom of contaminated sites (USEPA, 1985).

Subsurface barriers require a continuous impermeable subsurface zone to which the barrier may be attached. At NL Pedricktown, the impermeable clay layer has a variable depth of 5 to 30 feet and is intermittently discontinuous throughout the Site. Non-uniformity in the impermeable clay layer may cause lensing whi would make both grout curtains and slurry walls non-effective. Therefore the use of subsurface barriers as a technology is not retained for further consideration.

3. Treatment Technologies

There are several remediation techniques for treating ground water containing metals such as arsenic, lead, and cadmium. Many of the technologies discussed have been extensively tested and are commercially available. Several are still nder development and/or testing at the bench-scale, pilot-scale, and/or full-s le level. These technologies are screened for further evaluation based on implementability, effectiveness, and cost.

PHYSICAL/CHEMICAL TREATMENT

Precipitation/Flocculation: Precipitation is the process of converting a soluble substance to an insoluble substance. Precipitation can be used to remove the following metals from waste: arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc (Freeman, 1989). Although several precipitants have been proven to be effective, hydroxide precipitation using lime is the method most widely used (Freeman, 1989). Precipitation is usually carried out in a stirred reaction tank. After the metals have been converted to an insoluble form by chemical and physical processes, the solution is usually sent to a clarifier or holding tank where the solids are allowed to settle. To improve the effectiveness of suspended solids removal, flocculation can be performed.

Flocculation is the process of combining small, unsettleable particles into larger, more settleable "flocs". Because of low weight, small particles remain suspended in a liquid medium until conditions allow them to attach to other particles and form flocs. Flocculation occurs in two sequential mechanisms. First, the surface of the particles is destabilized using chemical agents so the particles no longer repel each other. Second, the particles begin to attach through chemical bridging and physical enmeshment forming larger particles.

As treatment technologies, precipitation and flocculation are well-established and have operating parameters that are well-defined. The basic equipment (e.g., chemical pumps, metering devices, mixing tanks, and settling tanks) is readily available and relatively simple to operate. Precipitation and flocculation systems can also be integrated into more complex treatment systems.

One major disadvantage of precipitation and flocculation is that they are non-destructive processes and generate a large volume of sludge (which must be treated and/or disposed). Also, precipitation is non-selective; therefore, compounds other than the ones desired may be removed, reducing the effectiveness of removal of the target compounds. There are, however, many different precipitation and flocculation agents that are selective for certain ions or species. Also, by varying the pH and dosage of reagents, optimal removal of specific compounds can be achieved. The performance and reliability depends in part on the composition of the waste being treated. Laboratory tests are required to determine the proper chemical addition; adjustments must be made with any compositional changes of the waste.

Precipitation/flocculation as a treatment technology will be retained for further consideration. There are many reagents that can be used as precipitants. The following processes have been found to be effective for lead, cadmium, and/or arsenic removal.

<u>Hydroxide Precipitation</u> [Precipitants: $Ca(OH)_2$, $Na(OH)_2$]

$$M^{++} + Ca(OH)_2 \text{ -------------------------> } M(OH)_2 + Ca^{++}$$

The effectiveness of hydroxide precipitation depends on:

- metals present;
- precipitant used;
- reaction conditions (especially pH); and
- presence of other materials which may inhibit precipitation.

Precipitants that can be used are calcium hydroxide (lime) or sodium hydroxide (caustic). Most metals will form precipitates at pHs between 9 and 11. Lime is typically used due to its availability, low cost, and ability to be stored on-site.

One disadvantage of hydroxide precipitation is that each metal precipitates at a different optimal pH value. So in creating conditions to precipitate one metal hydroxide the precipitation of another may be hindered. For example, the optimum pH to precipitate cadmium hydroxide is roughly 11.0, while lead can be precipitated most effectively at a pH of 8.5 to 9.0. It should be noted that for lead precipitation, effluent concentrations only on the order of 10 mg/l are obtainable (Freeman, 1989).

<u>Sulfide Precipitation</u> [Precipitants: Na_2S, NaHS, FeS]

$$M^{++} + FeS \text{ -------------------------> } MS + Fe^{++}$$

The solubilities for sulfide precipitation are much lower than those for hydroxide precipitation. For example, lead can be removed to 10^{-7} mg/l at a pH of 11. During sulfide precipitation, however, toxic hydrogen sulfide gas may be generated. This occurs

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at a pH above 8. Also, the effluent of the treated water may contain excess sulfide which may require posttreatment.

Sulfide sources that have been used for precipitation include: sodium sulfide (Na_2S) or sodium hydrosulfide (NaHS) which are soluble; and ferrous sulfide (FeS), which is only slightly soluble. Ferrous sulfide has been found to be practicable because it is soluble enough to precipitate other heavy metals but does not dissolve readily creating a very low free sulfide concentration. Ferrous sulfide, however, is very unstable and must be generated on-site. This poses the risk of hydrogen sulfide generation. The Sulfex process is based on the use of ferrous sulfide, along with other reagents (Freeman, 1989).

Carbonate Precipitation [Precipitants: Na_2CO_3]

$$Na_2CO_3 + M^{++} \text{------------------------>} MCO_3 + 2Na^{+}$$

Precipitation using sodium carbonate (soda ash) is effective for certain metals including lead and cadmium. Effluent concentrations using soda ash will be similar to those achieved by hydroxide precipitation. However, for carbonate precipitation, a lower pH of 7.5 to 8.5 can be used instead of a pH of 10 or greater required by hydroxide precipitation. Also, carbonate has been found to produce a denser, more filterable sludge. However, soda ash is not effective for all metals and has been proven ineffective for zinc and nickel (Freeman, 1989).

Sodium Borohydride Precipitation [Precipitants: $NaBH_4$]

$$4M^{++} + NaBH_4 + 2H_2O \text{--------------->} NaBO_2 + 4M + 8H^{+}$$

$$4M^{++} + NaBH_4 + 8OH^- \text{--------------->} NaBO_2 + 4M + 6H_2O$$

Sodium borohydride can be used to precipitate metal in its insoluble elemental form. It is effective for removing lead, mercury, nickel, copper, cadmium, and precious metals (e.g., gold, silver, platinum). The optimum pH range for this reducing agent is between 8 and 11 and is determined by finding the balance between borohydride usage and reaction time/effluent quality. Sodium borohydride can be purchased as a free-flowing active powder or as a stabilized solution of sodium borohydride in caustic soda (Freeman, 1989).

Iron Coprecipitation [Precipitants: $FeCl_3$, & other ferric salts]

$$FeCl_3 + 3H_2O \text{ ------------------------> } Fe(OH)_3 + 3Cl^- + 3H^+$$

Coprecipitation with amorphous iron oxyhydroxide can be used to remove trace elements (e.g., arsenic, selenium, cadmium, chromium, cooper, lead, silver, and zinc). These trace elements are adsorbed onto and trapped within the precipitate.

Results from laboratory ..sts indicate that arsenate is as strongly removed by iron as is arsenite (Merrill, et. al., 1986).

Ferrihydrite (Iron Hydroxide)

A study conducted comparing metal removal efficiencies of hydroxide precipitation and adsorption onto ferrihydrite resulted in the discovery that ferrihydrites removed an equal or greater percentage of soluble Cu, Cd, Zn, Cr(III), Ni, and Pb from synthetic wastes regardless of pH. An additional advantage of ferrihydrite is that it can be regenerated and reused to absorb metals with no measurable loss in metal-removing efficiency. Also, there is no significant chemical cost difference in using ferrihydrite adsorption with regeneration and hydroxide precipitation. There is also a reduction in sludge generation by separating ferrihydrite from the waste and reusing it.

According to EPA, precipitation is one of the best available technologies (BAT) for treating ground water containing lead and cadmium. For these two metals, four treatment train options were given in the Development Document. For lead removal, all four BAT treatment train options contained chemical precipitation. Three of the four trains indicated using lime and carbonate as precipitants. The third option indicated sulfide addition. Three of the four trains also indicated filtration (or polishing filtration) as a part of the treatment. One of the four options indicated reverse osmosis as part of the treatment (USEPA, 1984).

For removal of cadmium from ground water, again, all four BAT treatment train options included precipitation. Three of the four trains also used polishing filtration. Two of the four trains incorporated reverse osmosis as part of the treatment process. One treatment train included ion exchange as part of the process (Edwards, and Benjamin, 1989).

As discussed above, flocculation is often used in conjunction with precipitation. Chemical agents used in flocculation (coagulants) include alum, lime, various iron salts, and organic flocculating agents known as "polyelectrolytes" or "polymers".

Adsorption onto Activated Alumina

From a study, adsorption onto activated alumina was found to be one effective method for arsenic removal, especially for arsenate (As(V)) removal. The optimum pH for removing arsenic is 6.0. Also, adsorption onto activated alumina is effective for fluoride removal. For removal of arsenite (As(III)), preoxidation is necessary to convert the As(III) to As(V). This can be accomplished by adding 1 mg/L of free chlorine at a pH of 6 to 10. Any total organic carbon (TOC) present, however, will slow down the reaction. Also, 1.0 mg/L combined chlorine (e.g., mono-chloramine) oxidizes 45% of As(III) to As(V) (Frank and Clifford, 1986). Due to lack of information on its effectiveness for lead removal, this process option will not be retained for further analysis.

Evaporation

Evaporation is the conversion of a liquid into a vapor. The main goal in evaporation is to concentrate a solution made up of:

1) a volatile solvent, and
2) a solute which is not appreciably volatile.

The residue produced by evaporation is usually a viscous liquid as opposed to a solid which is produced from a drying process. The process equipment is quite flexible and can handle wastes in a variety of forms (e.g., aqueous liquids, non-aqueous liquids, slurries, sludges, and tars) (Freeman, 1989).

The major disadvantages of evaporation are its high capital and operating costs. Energy requirements are high, and potential maintenance problems include salt buildup on heat-exchange surfaces, foaming, and solids decomposition (Freeman, 1989). Evaporation, due to high costs and materials handling requirements, is usually only considered when no other technology is feasible. Therefore, this process will not be retained for further consideration.

Ion Exchange

Ion exchange is a process which is capable of replacing toxic ions in an aqueous solution with non-toxic ions housed in a resin. Ion exchange resins are made of synthetic organic materials containing ionic functional oups. These functional groups can release certain harmless ions while attracting toxic ions to replace the ions in the resin. The resins are made to function under a wide range of pH and temperature conditions. Ion exchange can be used to remove all metallic elements when they are in solution as anions and cations (USEPA, 1985).

Ion exchange is a well-established technology for the removal of heavy metals and hazardous ions from a waste stream. The equipment for this treatment process is compact, not energy intensive, and readily available. A resin can treat from 2500 to 4000 mg/l before regeneration is necessary (USEPA, 1985). The higher the concentration of the contaminants, however, the quicker the resin will be exhausted and have to be regenerated. Capital and operating costs can be prohibitive for this treatment technology. Operating costs for this process are two-fold. First, there is the cost of regenerating the resin (which includes treating and/or disposing of the waste). Secondly, there is the costs associated with redundant equipment. While one resin is being regenerated another is in operation. The other option is to have sufficient water storage while one resin is being regenerated.

A major operating constraint of ion exchange is that suspended solids in the feed stream must be less than 50 mg/l to prevent the resin from being clogged. Therefore, many waste streams require pretreatment before they can be fed.

Representatives from three resin manufacturing companies were contacted in order to determine the best resins for arsenic, cadmium, and lead removal. A chelating resin was recommended to remove both cadmium and lead. All representatives that were contacted indicated that arsenic removal would be difficult using ion exchange. Most recommended two columns; one for lead and cadmium and one for arsenic. Costs of resins and resin regeneration are considered high in comparison with other treatment technologies. However, ion exchange is technically feasible and would be an effective polishing step for achieving stringent action levels for metals. Therefore, this process will be retained for further consideration.

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Ion Medium Filtration

This technology is like ion exchange in that metal-contaminated water is passed through a medium that selectively bind cations. The difference between ion medium filtration and ion exchange is that ion medium filtration uses a disposable canister containing a granular solid medium instead of a regenerable resin. This technology, however, is still at a pilot-scale level. Since this technology is still under development, it will not be retained for further consideration.

Reverse Osmosis (RO)

Reverse Osmosis (RO) is a process that forces the net flow of a solvent (water) to go through a semipermeable membrane toward the dilute solute phase instead of the more concentrated solute phase. This process requires a high-power pump because the natural flow of water is toward the more concentrated solute solution. This natural process is called osmosis.

Reverse osmosis is widely accepted for separating water from inorganic ions. One benefit is that in some cases, both the solvent (usually water) and concentrated solute are pure enough to be recycled to a manufacturing process instead of needing treatment and/or disposal. Also, the process is not energy-intensive; thus, there are relatively low operating costs (Freeman, 1989).

The disadvantages of reverse osmosis are based upon the need to have a solution free of particulates and all other substances that are harmful to the membrane, as the units are highly susceptible to plugging and fouling. Most wastewater must be pre-treated before being sent through a reverse osmosis system (Freeman, 1989). Due to extensive pretreatment requirements, and associated costs, this process will not be retained for further consideration.

Hyperfiltration (HF) and Ultrafiltration (UF)

Hyperfiltration (HF) and ultrafiltration (UF) use a semipermeable membrane to separate non-ionic compounds from a solvent (usually water). Non-ionic materials generally removed by these processes include suspended solids, oil and grease, large organic molecules, and complexed heavy metals. Both HF and UF use the same operating principle. Hyperfiltration generally removes species with molecular weights between 100 and 500 whereas ultrafiltration removes species with molecular weights of 500 or more (Freeman, 1989).

The effectiveness and cost of both HF and UF depend primarily on the membrane. Two common materials used for membranes are: polysulfone and cellulose acetate. (Freeman, 1989). Due to the lack of effectiveness for removing ionic species this technology will not be retained for further consideration.

BIOLOGICAL TREATMENT

The Bio-Recovery Systems, Inc., Biological Sorption Process

AlgaSORB[R] is a new technology for the removal and recovery of heavy metal ions from groundwater. This technology is being tested for its effectiveness on "difficult to remove" metal ions and those that contain high levels of dissolved solids from ground water or surface leachates. This biological sorption process utilizes the natural affinity of algae cell walls for heavy metal ions. This process has shown promising results for mercury and is designed to remove other heavy metals, including lead. This process is under development by the SITE Emerging Technologies Program. Since this process option is still being developed, it will not be retained for further consideration (USEPA, 1990).

Colorado School of Mines' Wetlands-Based Treatment

This treatment technology is based on the natural biological and geochemical process that occurs in man-made wetlands in order to accumulate and remove metals from contaminated water. The treatment technology utilizes major components from wetlands ecosystems including organic soils, microbial fauna, algae, and vascular plants. Before treatment, the contaminated water must have a low pH. It is first sent through the aerobic and anaerobic zones of the wetland ecosystem. Process that occur in these zones include filtration, ion exchange, adsorption, absorption, and precipitation through geochemical microbial oxidation and reduction. This technology has been entered into the SITE Emerging Technologies Program by the Colorado School of Mines. Since this technology is still under development, it will not be retained for further consideration (USEPA, 1991a).

DISCHARGE TECHNOLOGIES

Reinjection to Unconfined Aquifer via Infiltration Pond: In order to reinject the ground water, the treated water must meet the Federal Action Level of 15 ppb for lead or AWQC (depending on the reinjection system location). Due to the high water table at the Site and the large volume of water to be reinjected, an infiltration pond is a feasible process option and will be retained for further evaluation.

Reinjection to Unconfirmed Aquifer via Leach Field: The use of a leach field will be considered for the reinjection of treated ground water to the unconfirmed aquifer. Preliminary calculations indicate a leach field of approximately 30 acres will be required for the 250 gpm flow rate. The placement of this system would be most favorable in an upgradient location. However, the property required for construction is not readily available. Additional testing will be conducted during the remedial design to confirm the effectiveness and practicality of this option.

Reinjection to Unconfirmed Aquifer via Infiltration Trenches: The use of infiltration trenches will be considered from the reinjection of treated ground water to the unconfirmed aquifer. Preliminary calculations indicate infiltration trenches would require an area of 20 acres. As with the leach field, placement would be most favorable in an upgradient location. Off-site property constraints are a concern for possible construction. Additional testing will be conducted during the remedial design to confirm the effectiveness and practicality of this option.

Reinjection to Unconfirmed Aquifer via Reinjection Wells: The use of reinjection wells to discharge treated ground water to the unconfirmed aquifer will also require further evaluation. Due to the high water table and the inherent well inefficiencies associated with reinjection an extremely large reinjection area would be required. The capillary effects and hydroscopic nature of the unsaturated zone may result in the number of reinjection wells being 2 to 2.5 times the number of recovery wells. Further evaluation will be performed during the remedial design to confirm these concerns and to evaluate the practicality of this option.

Reinjection to Confined Aquifer (Deep Injection Wells): As an alternate to injecting to the water table, deep injection wells could be used to discharge treated ground water to a confined aquifer water would be treated to meet The Federal Action Level of 15 ppb for lead. Previous aquifer characterization studies (see Geraghty & Miller Report - Ma 1983) indicates recovery and reinjection to the confined aquifer may be possible. Further evaluation during the remedial design will be required.

Discharge to the East or West Stream: In order to discharge the treated ground water to the surface water, it must meet the Ambient Water Quality Criteria (AWQC) for freshwater surface streams. AWQC for metals such as lead is a function of the hardness of the water. The higher the hardness, the higher the acceptable metal concentration. The treatment process will include pH control with a lime slurry. This process will be retained for further consideration.

Discharge to the Delaware River: In order to discharge treated ground water to the Delaware River, Ambient Water Quality Criteria must be met. In order to do this, ground water could be treated on-site or transported to an off-site treatment plant which is currently located on the Delaware River approximately 5-10 miles south of the Site. Transportation process options include constructing a pipeline or using a Delaware River barge. ~~Due to the expense and low implementability, this process option will not be retained for further consideration.~~The advantage of river discharge lies in the potential cost savings in on-site treatment costs associated with less stringent surface water discharge criteria or off-site treatment plant pretreatment criteria in comparison to the subsurface discharge criteria. However, upon analysis, the cost savings realized through less stringent discharge criteria is less than the additional cost required to construct an outfall to the river from the Site. In addition, the probable route of such an outfall would necessitate road replacement and would impact an existing in-use railway. The accommodation of these issues during design and construction and in obtaining the necessary permits is a costly and time consuming endeavor. Therefore, due to the expense and low implementability, this process option will not be retained for further consider.

NLI 002 1002

4. Removal Technologies

Pumping Using Recovery Well Systems

Ground water pumping can be achieved using recovery well systems. Well systems can be used to contain, remove, divert, or prevent development of a plume under various site conditions. Sites with aquifers that have high intergranular hydraulic conductivity show the greatest effectiveness of contaminant removal using pumping (Freeman, 1989). Two types of recovery well systems will be discussed:

Well Point System: A ground water abatement system has been installed at the Site. This system consists of 49 well points distributed throughout the Site. The use of this installed system will be retained for further evaluation.

Submersible Pumps: Submersible pumps are able to lift water from depths of 100 feet or more. One advantage of submersible pumps is that they are relatively slender for their capacity and therefore can be used in wells with smaller diameters. Submersible pumps with capacities of 100 gallons per minute are available some of which have motors of several hundred horsepower (USEPA, 1985). However, the pumps for this Site are anticipated to have a much smaller capacity, roughly on the order of 5 gallons per minute. These pumps are readily available at a reasonable cost. The use of submersible pumps will be retained for further evaluation. The technologies described in this appendix were evaluated based on information from previous studies and waste treatment manuals. All sources referenced are listed in the reference at the conclusion of the main report.

NLI 002 1003

APPENDIX I-1

SCREENING OF REMEDIAL TECHNOLOGIES - SEDIMENTS SOUTH OF U.S. RTE. 130

APPENDIX I-1
SCREENING OF REMEDIAL TECHNOLOGIES -
SEDIMENT SOUTH OF U.S. ROUTE 130

1. Institutional Technologies

The following institutional actions could be implemented at the Site:

Access Restrictions: Access restrictions are utilized to limit contact with waste materials by the general public.

Fencing: Fencing provides a method of physically preventing access to a site. However, preventing access to a stream would require fencing along the stream course which is not only many thousands of feet long but would disrupt the surrounding ecosystem. This option will not be retained for further consideration.

2. Containment Technologies

The goal of containment technologies is to eliminate the spread of contaminants by preventing access to transport pathways. Due to the nature of this media, available containment technologies are not feasible for in-situ applications and Appendix G is referenced for ex-situ applications. Study site characteristics allow the following as a containment technology.

Stream Diversion: Stream diversion involves diverting the stream flow from its original course with an alternate conveyance to eliminate contact of stream water with the contaminated sediment. Sediment removal is addressed in Sections 3 and 4 of this appendix. Flow would re-enter the original stream course at a point further downstream where diversion is not required. Several alternate conveyances are available.

Channel: Channels used for stream diversion are open excavations sized and positioned to allow flow diversion of a portion of an existing stream while maintaining the overall integrity of the stream. Cofferdams can be used for flow diversion. Cofferdams are typically constructed of soil, sheet pilings, earth-filled sheet pile cells or sand bags. Channels can be either temporary or permanent conveyances and are relatively inexpensive and require little maintenance. This option will be retained for further consideration.

NLI 002 1005

Piping: Piping provides flow diversion the same as a channel. Piping, however, cannot function ecologically as a stream, and could only be considered as a temporary diversion. Though effective, cost is prohibitively high compared with channels. In addition, collection and pumping equipment which would be required to accommodate 75% of the 10 year flood flow at the NL Industries site could not be adequately sited or constructed a the site. Therefore, this option will not be retained for further consideration.

Hydraulic: This option involves creating a holding basin to intercept stream flow and pump the basin water to the stream past the portion of the stream targeted for diversion. Again, this option is considered a temporary diversion only. Though effective, cost and maintenance are very high; therefore, this option will not be retained for further consideration.

3. Treatment Technologies

The USEPA indicates a regulatory trend to allow sediment that has been removed, and pretreated (if necessary), to then be treated as a soil (M. Borst, 1991). Treatments available for soils are addressed in Appendix G. The screening of sediment treatment technologies will, therefore, be limited to technologies which generally improve material handling characteristics.

Dewatering: The goal of dewatering is to decrease the ratio of water mass to total sediment mass. Dewatering is usually required when sediments are to be subjected to soil treatment technologies and the sediment was removed by a hydraulic dredging technology. Dewatering allows easier handling and transporting, as well as potential land disposal. Dewatering can be accomplished through natural or mechanical processes. Natural processes include evaporation and gravity drainage. Mechanical processes involve the use of mechanical persuasion to force water from the sediments. Several processes are available:

Confined Disposal Facility (CDF): CDF is an engineered structure enclosed by a dike designed to retain dredged material and allow evaporation and gravity drainage of dredged materials. A smaller impoundment typically adjoins the CDF; turbid, supernatant water is allowed to flow from the CDF to the smaller impoundment to enhance dewatering. Critical considerations include location, hydrogeology and the local environment. CDFs are

NLI 002 1006

typically used for highly liquid spoils and not for near in-situ density sediments. This option will not be retained for further consideration.

Mechanical: There are two type of mechanical dewatering available. A filter press and a centrifuge. A filter press provides mechanical dewatering by "squeezing" water from sediment using tensioned porous belts or rigid, individual positive pressure filtration chambers. Flocculating additives can aid in dewatering efficiency. Though effective at dewatering sediments, filter presses can be costly to operate and maintenance intensive. The centrifuge uses material density differences and centrifugal force generated by a rapidly rotating cylindrical unit to dewater sediments. Two types of centrifuges are available: the solid bowl type and the basket type. Centrifuges are generally less efficient than filter presses or CDFs, maintenance and operation intensive, and relatively costly. Therefore, the mechanical dewatering option will not be retained for further consideration.

Portland Cement: Type I or Portland cement acts to dewater sediments through hydration. Depending on the mixture, the resulting solid demonstrates a considerable increase in weight and volume. Also, physical properties such as bearing capacity and durability can increase. Portland cement is considered readily available and relatively inexpensive, and the mixing process uses common equipment and training. This option will be retained for further consideration.

Solidification/Stabilization (S/S): Refer to Appendix G for a screening of S/S technologies.

4. Removal Technologies

Removal technologies involve the use of mechanical or hydraulic techniques to remove sediment.

Mechanical Dredging: Mechanical dredging provides for removal of sediment at near in-situ densities to allow proportional transportation and disposal. Mechanical dredges can be crane/boom superstructures that operate the dredging device by cables. They can be barge mounted for work in large bodies of water or can be crawler or wheel mounted for work from shore when water surface area is limited. For small streams (less than 10 feet wide) with limited access, non-crane type excavation equipment may be more appropriate.

NLI 002 1007

Clamshell/Orangepeel - A bucket is opened, dropped into the sediment, closed and hoisted out. The bucket capacity ranges from 1 to 12 cubic yards and can be used to depths of 100 feet. Clamshell/orangepeel devices are typically used to remove soft and cohesive material from water courses which have low current velocities. Removed sedime can be placed in scows, hop r barges, or trucks and taken to disposal. Considerable idity can occur from the action of the clamshell during both the excavation stage and the hoisting/loading stage. Though production is low compared to hydraulic dredges, clamshell operational control is good and precision dredging is adequate. A wheel-mounted clamshell dredge could be used for portions of the stream course that have existing access. Although the clamshell is commonly used, it may not be available in all areas. Because clamshells require a crane and associated access, this option will not be retained for further consideration.

Dragline - Similar to the clamshell, the dragline dredge is a monolithic bucket that is lowered to the sediment surface and winched horizontally toward the barge or truck-mounted crane. This causes the bucket to excavate sediment which is hoisted to the surface and emptied into the means of transport. Dragline bucket capacities are similar to those for clamshell buckets. Production is low but so is the cost. Operational control is generally good when barge-mounted and fair when wheel-mounted, but precise dredging is poor in either application. This option will not be retained for further consideration.

Backhoe - Various portions of the stream course do not have sufficient access for a barge- or truck-mounted crane but have enough access for a rubber tire backhoe. Availability is essentially unlimited and cost is low. Operational control is good as is precision. This option will be retained for further consideration.

Backhoe with Access Stabilization - Portions of the stream course feasible for dredging by a backhoe are paralleled by non-submerged areas of the overall stream course. These areas consist of very soft soils requiring stabilization to be suitable for use by equipment. Stabilization could be accomplished by the application of base course aggregate, flexible geogrid mat with backfill or wired timber mat. This option will be retained for further consideration.

NLI 002 1008

Bucket Ladder - A bucket ladder is composed of a slender conveyor system with a continuous series of buckets which, when rotating, scoop and carry sediment to the surface and dump it into an onboard hopper of scow. Each bucket volume ranges from 1/3 to 4 cubic yards and can reached depths of 60 feet. This option is limited to barge-mounted applications and its availability is limited; this option will therefore not be retained for further consideration.

Hydraulic Dredging: This process involves the use of centrifugal pumps to remove sediment by suction in liquid slurry form. Mechanical persuasion can be used in combination with the suction action to expedite sediment removal. Hydraulic dredging limits the resuspension of dredged sediments, is applicable to water courses with considerable current velocities and allows removal of free or unabsorbed liquid contaminants. Sediment slurries can be pumped, potentially many thousands of feet, to a disposal/storage area. These slurries can require dewatering if treatment or conventional transportation is needed. Slurries are typically 10 to 20 percent solids but can contain up to 60 percent solids. Production is a function of sediment characteristics, pumps, process option, and operator experience.

Hydraulic dredges can be mounted on self-propelled barges, winched-propelled portable barges, or self-propelled seagoing vessels. Self-propelled barges and seagoing vessels require navigable waterways to operate but winch-propelled barges are portable and can easily be launched, retrieved and moved overland without major dismantling. Portable dredges can operate in water courses that are as little as 10 feet wide and 2 feet deep. The identified process options are those that are routinely used on portable dredge vessels.

Cutterhead - A cutterhead uses a suction line with a rotating conical or wheel cutter apparatus at the intake to dislodge sediment for removal via the suction line as the apparatus sweeps in a back and forth motion. It can be used in most soil types and for sediments that contain large quantities of debris. Though operational control and precision are good; cost is average compared with other hydraulic options and resuspension can be small when operated properly, however, stream size limitations preclude its use. This option will not be retained for further consideration.

NLI 002 1009

Dustpan - A dustpan is a suction line at the base of a large scoop with high pressure water jets along its top edge. It can be effective in free-flowing granular material but substantial resuspension and/or clogging would occur with fine grained, cohesive material. Operational control and precision is adequate; however, dustpans have been shown to be less efficient than other options screened. This option will not be retained for further consideration.

Horizontal Auger - A horizontal auger has cutter knives that dislodge material as the unit moves forward and a spiral auger that channels sediment to the suction intake. A mud shield is used to limit re-suspension of sediment and aid in the channelling effect towards the suction intake. Horizontal augers are effective in most sediment conditions. Operational control and precision are good. Its availability on barges less than 9 feet wide and its high efficiency compared to the other options at small sites gives this option an excellent reputation. Again, the stream size limitations preclude this option from being effective, so it will not be retained for further consideration.

Matchbox - A matchbox has a suction line intake inside a plate enclosure. The enclosure is typically a triangle shape with a vertex pointed forward and valve-controlled openings on the two forward sides. The leeward side valve is closed to limit water/suspended sediment flow out of the enclosure as the dredge sweeps back and forth. This option has limited availability in general and especially when applied to portable dredges. This option will not be retained for further consideration.

Pneuma - Pneuma units consist of three positive displacement pumps attached to the base of a scoop. The scoop is suspended by cable from the stern of the barge and attached to a cable over a bow pulley. As the barge is winched forward, the scoop is "pulled" forward through the sediment. The units are arranged such that as sediment accumulates in the scoop, it fills the displacement cylinders. Continuous operation is achieved by sediment level indicators in each cylinder that individually energized. Each cylinder fills with sediment through a bottom intake port, compressed air is applied through a top air port when the sediment level indicator is energized, the bottom intake port closes and sediment is forced to the surface through a top discharge port. Availability of pneuma units is considered limited and durability is untested. This option will not be retained for further consideration.

NLI 002 1010

The technologies described in this appendix were evaluated based on information from previous studies and waste treatment manuals. All sources used are listed in the reference section at the conclusion of the main report.

APPENDIX I-2

SCREENING OF REMEDIAL TECHNOLOGIES - SEDIMENTS NORTH OF U.S. RTE. 130

APPENDIX I-2
SCREENING OF REMEDIAL TECHNOLOGIES - SEDIMENT NORTH OF U.S. ROUTE 130

1. Institutional Technologies

The following institutional actions could be implemented at the Site:

Access Restrictions: Access restrictions are utilized to limit contact with waste materials by the general public.

Fencing: Fencing provides a method of physically preventing access to a site. However, preventing access to a stream would require fencing along the stream course which is not only many thousands of feet long but would disrupt the surrounding ecosystem. This option will not be retained for further consideration.

2. Containment Technologies

The goal of containment technologies is to eliminate the spread of contaminants by preventing access to transport pathways. Due to the nature of this media, available containment technologies are not feasible for in-situ applications and Appendix G is referenced for ex-situ applications. Study site characteristics allow the following as a containment technology.

Stream Diversion: Stream diversion involves diverting the stream flow from its original course with an alternate conveyance to eliminate contact of stream water with the contaminated sediment. Sediment removal is addressed in Sections 3 and 4 of this appendix. Flow would re-enter the original stream course at a point further downstream where diversion is not required. Several alternate conveyances are available.

Channel: Channels used for stream diversion are open excavations sized and positioned to allow flow diversion of a portion of an existing stream while maintaining the overall integrity of the stream. Cofferdams can be used for flow diversion. Cofferdams are typically constructed of soil, sheet pilings, earth-filled sheet pile cells or sand bags. Channels can be either temporary or permanent conveyances and are relatively inexpensive and require little maintenance. This option will not be retained for further consideration,

NLI 002 1013

due to the size of the stream segments in questions, constructed channels would be of sufficient size to significantly impact the surrounding environment.

Piping: Piping provides flow diversion the same as a channel. Piping, however, cannot function ecologically as a stream, and could only be considered as a temporary diversion. Though effective, cost is prohibitively high compared with channels. In addition, collection and pumping equipment which would be required to accommodate 75% of the 10 year flood flow at the NL Industries site could not be adequately sited or constructed at the site. Therefore, this option will not be retained for further consideration.

Hydraulic: This option involves creating a holding basin to intercept stream flow and pump the basin water to the stream past the portion of the stream targeted for diversion. Again, this option is considered a temporary diversion only. Though effective, cost and maintenance are very high; therefore, this option will not be retained for further consideration.

3. Treatment Technologies

The USEPA indicates a regulatory trend to allow sediment that has been removed, and pretreated (if necessary), to then be treated as a soil (M. Borst, 1991). Treatments available for soils are addressed in Appendix G. The screening of sediment treatment technologies will, therefore, be limited to technologies which generally improve material handling characteristics.

Dewatering: The goal of dewatering is to decrease the ratio of water mass to total sediment mass. Dewatering is usually required when sediments are to be subjected to soil treatment technologies and the sediment was removed by a hydraulic dredging technology. Dewatering allows easier handling and transporting, as well as potential land disposal. Dewatering can be accomplished through natural or mechanical processes. Natural processes include evaporation and gravity drainage. Mechanical processes involve the use of mechanical persuasion to force water from the sediments. Several processes are available:

NLI 002 1014

Confined Disposal Facility (CDF): CDF is an engineered structure enclosed by a dike designed to retain dredged material and allow evaporation and gravity drainage of dredged materials. A smaller impoundment typically adjoins the CDF; turbid, supernatant water is allowed to flow from the CDF to the smaller impoundment to enhance dewatering. Critical considerations include location, hydrogeology and the local environment. CDFs are typically used for highly liquid spoils and not for near in-situ density sediments. This option will not be retained for further consideration.

Mechanical: There are two type of mechanical dewatering available. A filter press and a centrifuge. A filter press provides mechanical dewatering by "squeezing" water from sediment using tensioned porous belts or rigid, individual positive pressure filtration chambers. Flocculating additives can aid in dewatering efficiency. Though effective at dewatering sediments, filter presses can be costly to operate and maintenance intensive. The centrifuge uses material density differences and centrifugal force generated by a rapidly rotating cylindrical unit to dewater sediments. Two types of centrifuges are available: the solid bowl type and the basket type. Centrifuges are generally less efficient than filter presses or CDFs, maintenance and operation intensive, and relatively costly. Therefore, the mechanical dewatering option will not be retained for further consideration.

Portland Cement: Type I or Portland cement acts to dewater sediments through hydration. Depending on the mixture, the resulting solid demonstrates a considerable increase in weight and volume. Also, physical properties such as bearing capacity and durability can increase. Portland cement is considered readily available and relatively inexpensive, and the mixing process uses common equipment and training. This option will be retained for further consideration.

Solidification/Stabilization (S/S): Refer to Appendix G for a screening of S/S technologies.

4. Removal Technologies

Removal technologies involve the use of mechanical or hydraulic techniques to remove sediment.

NLI 002 1015

Mechanical Dredging: Mechanical dredging provides for removal of sediment at near in-situ densities to allow proportional transportation and disposal. Mechanical dredges can be crane/boom superstructures that operate the dredging device by cables. They can be barge mounted for work in large bodies of water or can be crawler or wheel mounted for work from shore when water surface area is limited.

Clamshell/Orangepeel - A bucket is opened, dropped into the sediment, closed and hoisted out. The bucket capacity ranges from 1 to 12 cubic yards and can be used to depths of 100 feet. Clamshell/orangepeel devices are typically used to remove soft and cohesive material from water courses which have low current velocities. Removed sediments can be placed in scows, hopper barges, or trucks and taken to disposal. Considerable turbidity can occur from the action of the clamshell during both the excavation stage and the hoisting/loading stage. Though production is low compared to hydraulic dredges, clamshell operational control is good and precision dredging is adequate. A wheel-mounted clamshell dredge could be used for portions of the stream course that have existing access. Although the clamshell is commonly used, it may not be available in all areas. This option will be retained for further consideration.

Dragline - Similar to the clamshell, the dragline dredge is a monolithic bucket that is lowered to the sediment surface and winched horizontally toward the barge or truck-mounted crane. This causes the bucket to excavate sediment which is hoisted to the surface and emptied into the means of transport. Dragline bucket capacities are similar to those for clamshell buckets. Production is low but so is the cost. Operational control is generally good when barge-mounted and fair when wheel-mounted, but precise dredging is poor in either application. This option will not be retained for further consideration.

Bucket Ladder - A bucket ladder is composed of a slender conveyor system with a continuous series of buckets which, when rotating, scoop and carry sediment to the surface and dump it into an onboard hopper of scow. Each bucket volume ranges from 1/3 to 4 cubic yards and can reached depths of 60 feet. This option is limited to barge-mounted applications and its availability is limited; this option will therefore not be retained for further consideration.

NLI 002 1016

Hydraulic Dredging: This process involves the use of centrifugal pumps to remove sediment by suction in liquid slurry form. Mechanical persuasion can be used in combination with the suction action to expedite sediment removal. Hydraulic dredging limits the resuspension of dredged sediments, is applicable to water courses with considerable current velocities and allows removal of free or unabsorbed liquid contaminants. Sediment slurries can be pumped, potentially many thousands of feet, to a disposal/storage area. These slurries can require dewatering if treatment or conventional transportation is needed. Slurries are typically 10 to 20 percent solids but can contain up to 60 percent solids. Production is a function of sediment characteristics, pumps, process option, and operator experience.

Hydraulic dredges can be mounted on self-propelled barges, winched-propelled portable barges, or self-propelled seagoing vessels. Self-propelled barges and seagoing vessels require navigable waterways to operate but winch-propelled barges are portable and can easily be launched, retrieved and moved overland without major dismantling. Portable dredges can operate in water courses that are as little as 10 feet wide and 2 feet deep. The identified process options are those that are routinely used on portable dredge vessels.

Cutterhead - A cutterhead uses a suction line with a rotating conical or wheel cutter apparatus at the intake to dislodge sediment for removal via the suction line as the apparatus sweeps in a back and forth motion. It can be used in most soil types and for sediments that contain large quantities of debris. Though operational control and precision are good; cost is average compared with other hydraulic options and resuspension can be small when operated properly, however, stream size limitations preclude its use. This option will not be retained for further consideration.

Dustpan - A dustpan is a suction line at the base of a large scoop with high pressure water jets along its top edge. It can be effective in free-flowing granular material but substantial resuspension and/or clogging would occur with fine grained, cohesive material. Operational control and precision is adequate; however, dustpans have been shown to be less efficient than other options screened. This option will not be retained for further consideration.

Horizontal Auger - A horizontal auger has cutter knives that dislodge material as the unit moves forward and a spiral auger that channels sediment to the suction intake. A mud shield is used to limit re-suspension of sediment and aid in the channelling effect towards the suction intake. Horizontal augers are effective in most sediment conditions. Operational control and precision are good. Its availability on barges less than 9 feet wide and its high efficiency compared to the other options at small sites gives this option an excellent reputation. Again, the stream size limitations preclude this option from being effective, so it will not be retained for further consideration.

Matchbox - A matchbox has a suction line intake inside a plate enclosure. The enclosure is typically a triangle shape with a vertex pointed forward and valve-controlled openings on the two forward sides. The leeward side valve is closed to limit water/suspended sediment flow out of the enclosure as the dredge sweeps back and forth. This option has limited availability in general and especially when applied to portable dredges. This option will not be retained for further consideration.

Pneuma - Pneuma units consist of three positive displacement pumps attached to the base of a scoop. The scoop is suspended by cable from the stern of the barge and attached to a cable over a bow pulley. As the barge is winched forward, the scoop is "pulled" forward through the sediment. The units are arranged such that as sediment accumulates in the scoop, it fills the displacement cylinders. Continuous operation is achieved by sediment level indicators in each cylinder that individually energized. Each cylinder fills with sediment through a bottom intake port, compressed air is applied through a top air port when the sediment level indicator is energized, the bottom intake port closes and sediment is forced to the surface through a top discharge port. Availability of pneuma units is considered limited and durability is untested. This option will not be retained for further consideration.

The technologies described in this appendix were evaluated based on information from previous studies and waste treatment manuals. All sources used are listed in the reference section at the conclusion of the main report.

NLI 002 1018

APPENDIX J

SOIL MANAGEMENT INFORMATION

State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF HAZARDOUS WASTE MANAGEMENT
CN 028
Trenton, N.J. 08625-0028
(609) 633-1408
Fax # (609) 633-1454

AUG 17 1990

MEMORANDUM

TO: Those Listed Below

FROM: Shirlee Schiffman, Chief
Bureau of Hazardous Waste Regulation and Classification

SUBJECT: Distribution of Soils Reuse Guidance Document

Attached for distribution to your staff and the public is the guidance document entitled "Management of Excavated Soils" developed by the Soil Reuse Committee. The guidance document defines three categories of soils, based on their levels of contamination, and describes management options for each category.

Please xerox the document as necessary for distribution.

PR13:nb
Attachment

c: Kate Joyce, BEERA
Ken Hart, ECRA
Dennis Hart, RPCE
Dave Zervas, RPCE
Jim Groome, RPCE
Ellen Bourbon, OR-DSWM
Guy Watson, OR-DSWM
Al Kaczoroski, DSWM
Ed Reardon, DSWM
Tom McNevin, BEERA
Phil Sandine, BEERA
Ken Goldstein, BUST
Sue Dengler, BGPA
Jill Monroe, BGPA
John Castner, DSWM
Arnold Schiffman, DWR
Howard Rubin, BRCTA
Wayne, Howitz, HW Enf.
Bruce Venner, BCTS
Vince Krisak, CFO
Dave Shotwell, NFO
Tom Downey, SFO
Yacoub Yacoub, MFO
Doug Stewart, BCTS

NLI 002 1020

MANAGEMENT OF EXCAVATED SOILS

This document presents guidance on the management of excavated soils, and explains which soils are of concern to the Department when excavated. The amount and type of contaminants present in soils puts them in one of three categories: 1) Hazardous waste, 2) Non-hazardous waste (ID27) or 3) Soils that contain contaminants below regulatory concern.

SOIL CATEGORIES

1. Hazardous Waste

Soil is considered to be hazardous waste when it is contaminated above the non-hazardous waste limits (Attachment I). These soils must be managed as hazardous waste in accordance with N.J.A.C. 7:26-1 et seq.

2. Non-Hazardous Waste

Soil is considered to be non-hazardous waste (ID 27) when it contains contaminants that are above Category 3 soil limits (Attachment II) and are below the hazardous waste limits (Attachment I). For assistance in categorizing a soil, contact the Bureau of Hazardous Waste Regulation and Classification (609-292-8341). There are several options available for soils categorized as non-hazardous wastes.

A. Disposal in the designated solid waste facility - Contact the Bureau of Solid Waste and Resource Recovery Planning (609-530-8599) within the Division of Solid Waste Management, or the appropriate county solid waste management official (Attachment III) for the appropriate facility;

B. Use as landfill cover - Contact the Bureau of Landfill Engineering (609-530-8008) within the Division of Solid Waste Management;

C. Treatment of soils prior to reuse - Contact the Bureau of Groundwater Pollution Abatement (609-292-8427) within the Division of Water Resources, or;

D. All other soil reuse options - Contact the Office of Recycling (609-530-4001) within the Division of Solid Waste Management.

3. Soils That Contain Contaminants Below Regulatory Concern

Soils that contain contaminants at levels that are below the Category 3 soil limits do not need to be classified and are, thus, suitable for use without treatment or prior approval. There are, however, certain conditions or circumstances that apply to those soils that are suitable for use:

A. Pinelands Preservation Area District - Soils generated outside the Pinelands Preservation Area District that contain contaminants at or below Category 3 levels shall not be moved from the site of generation into the Pinelands Preservation Area District, unless the soils are at or are below the receiving site's background levels. Soils generated in the Pinelands Preservation Area District that exceed background levels may not remain in the Pinelands Preservation Area District, but may be used elsewhere.

B. Objectionable Odors - Soils having objectionable odors shall not be used in residential areas or other locations where the public would be exposed. Specifically, the soils to be used must not violate the air pollution rules, N.J.A.C. 7:28-1 et seq.:

C. Regulatory Compliance - the soils must be used in accordance with all applicable federal, state and local regulations,:

D. Allowable Storage Time - The soils should not be stockpiled for more than six months from the time of excavation, and;

E. Soil Used As Fill - The use of soil mixed with other material (bricks, cement, asphalt, etc.) as fill shall follow the procedures set forth in the Division of Solid Waste Management's January 12, 1989 correspondence (Attachment IV).

Responsibility

It is the responsibility of the owner/operator to determine if soils are contaminated with any of the chemicals listed in Attachment II. Testing of soils from areas where contamination is unlikely (i.e. residential areas, etc.) is at the discretion of the generator. The possibility that contamination exists is greater in, but is not limited to, soils originating from industrial sites, discharge areas, potentially contaminated (PC) fills and tank areas. Therefore, the Department recommends that owner/operators considering these soils for use first perform analytical testing and retain copies of the results.

Recommended Testing Protocol for Category 3 Soils

For those owner/operators who believe that their soil may be contaminated or who are excavating soil to comply with the Department's requirements, the Department recommends the following minimum sampling and testing protocol:

1. Sampling

The Department recommends the following sampling strategy. For all samples, except those collected for Total Volatile Organic Compounds (VOC) analyses, one sample should be taken for every twenty cubic yards. Up to five samples can be composited per analysis. Thus, one analysis will be conducted for each 100 cubic yards of soil. For Total VOC analyses, one discrete subsurface sample should be taken for every 50 cubic yards of soil. Fill the container so that there is no head space. Immediately put it in ice and make sure the chilled sample is received by a DEP certified laboratory within 24 hours. There is no compositing of volatile organic samples.

2. Testing

When the owner/operator and/or Department has determined the need for testing, the following minimum analyses should be done (Attachment V):

A. If the origin and types of contaminants are known (such as soil from the removal of a gasoline tank) and there is no concern for potentially contaminated fill (Attachment VI), test the soil only for the known contaminant(s). If gasoline is the contaminant of concern, test for both total petroleum hydrocarbons and Total Volatile Organic Compounds (By GC Analysis). If other virgin fuel oils are the contaminant(s) of concern, test only for petroleum hydrocarbons.

B. If potentially contaminated fill is present and the soil will be used either off-site or on-site less than two feet below the surface, the soil should be analyzed for Priority Pollutant Metals in addition to the contaminant of concern.

C. If the source of contamination is unknown, then analyses need to be performed for: 1) Total Petroleum Hydrocarbons, 2) Priority Pollutant Metals and 3) Volatile Organic Compounds (VOC) using a Photoionization Detector/Organic Vapor Analyzer (PID/OVA). If PID/OVA screening determines that the VOC level is above background or if PID/OVA equipment is unavailable, then Total Volatile Organic Compound analyses should be performed.

Disclaimer

Soils exceeding Category 3 soil limits do not meet the definition of Category 3 soils and, therefore, must not be used without treatment or prior approval.

Persons excavating soil having contamination levels that are both above and below Category 3 soil limits should segregate the soil into piles based on contamination levels. This would expedite reuse of Category 3 soils.

The Department reserves the right to require testing, or conduct testing on its own. Should soils be considered unsuitable by the Department after their use, the generator of the soil is responsible for its proper removal and disposal, as well as for the remediation of all consequences of the use. Use of soils shall not relieve any person from obtaining any and all permits that are required from any federal, state, county or local agency. This document does not grant permission to fill or alter floodplain areas, riparian lands, freshwater wetlands or surface water runoff conditions without the appropriate approvals.

PR86:nb

MAXIMUM LIMITS FOR NONHAZARDOUS WASTES

Below are the NJDEP limits for analytical results performed in support of waste classifications. These limits are current as of 5/1/90, and represent the maximum concentrations allowable for nonhazardous wastes in New Jersey. The tests listed below are the minimum analytical requirements for contaminated soils when a letter of classification is required. Other types of wastes may require different, and possibly more extensive analyses. Additional analytical testing may be necessary for classification of soils, depending on the individual circumstances of each situation. For further information contact the Waste Classification Program at (609) 292-8341.

TEST	REGULATORY LIMITS (Nonhazardous limit)	
E.P. Toxicity (N.J.A.C. 7:26-8.12)	As	< 5.0 mg/l
	Ba	<100 mg/l
	Cd	<1.0 mg/l
	Cr	<5.0 mg/l
	Pb	<5.0 mg/l
	Hg	<0.2 mg/l
	Se	<1.0 mg/l
	Ag	<5.0 mg/l
	Endrin	<0.02mg/l
	Lindane	<0.4 mg/l
	Methoxychlor	<10.0 mg/l
	Toxaphene	<0.5 mg/l
	2,4-D	<10.0 mg/l
	2,4,5-TP	<1.0 mg/l
Ignitability--flash point performed on free liquids (N.J.A.C.7:26-8.9)	=>140 °F	
Corrosivity--performed on free liquids only (N.J.A.C. 7:26-8.10)	pH >2 and <12.5	
Total PCBs*(N.J.A.C. 7:26-8.20(b))	<50 mg/kg	

* The management of PCB containing waste also is regulated under the Federal TSCA regulations. For information on the TSCA rules, call (202) 554-1404.

ALI 002 1024

	NJDEP GUIDELINE LIMITS (Hazardous limits)
Reactivity (Applied to N.J.A.C. 7:26-8.11(a)5.)	reactive sulfide <500 mg/kg reactive cyanide <250 mg/kg
Total Petroleum Hydrocarbon Content (from spill of nonlisted oil) (Applied to N.J.A.C. 7:26-8.13(b)5.A.)	<30,000 mg/kg

Except for those wastes identified in N.J.A.C. 7:26-8.1(a)iii(1) through (5), and N.J.A.C. 7:26-8.2, the presence of detectable quantities of listed hazardous wastes (N.J.A.C. 7:26-8.13,8.14,8.15) makes a mixture of these and solid waste automatically hazardous, regardless of concentration (see N.J.A.C. 7:26-8.1(a)2.iii). Wastes containing hazardous constituents listed in N.J.A.C.7:26-8.16 require a "case by case" determination of their status in accordance with N.J.A.C. 7:26-8.6.

PR28:kww

Attachment II

CATEGORY 3 SOIL LIMITS

PARAMETER	MAXIMUM ALLOWABLE LEVEL (ppm)
Total petroleum hydrocarbons (TPHC)	100
Polycyclic Aromatic Hydrocarbons (PAH)	10
Priority Pollutants:	
Base neutrals (BN)	10
DDT	1
Chlordane	1
Polychlorinated biphenyls (PCB)	1
Volatile organics	1
Cyanide	12
Priority Pollutant Metals	
Antimony	10
Arsenic	20
Barium	400
Beryllium	1
Cadmium	3
Chromium	100
Copper	170
Lead	250
Nickel	100
Mercury	1
Molybendum	1
Selenium	4
Silver	5
Thallium	1
Vanadium	100
Zinc	350

Attachment III

LIST OF DISTRICT (C.326) SOLID WASTE MANAGEMENT OFFICIALS - APRIL 1990

TLANTIC

r. Jim Rutala
olid Waste Coordinator
tlantic Co. Utilities Authy.
701 Absecon Boulevard
tlantic City, NJ 08401
609) 348-3700

MDEN

r. Joseph Gilson
amden Co. Dept. of S. W. Mgt.
ast Building, 3rd Floor
981 No. Park Drive
ennsauken NJ 08109
609) 756-7875

SSEX

r. Martin Lund
ssex Co. Div. S.W. Mgt.
m.514 A - 465 Dr. Martin
uther King, Jr. Blvd.
ewark, NJ 07102
201) 621-6588

DSON

r. Al Fiore, Executive Dir.
udson Co. Imp. Authority
01 Pavonia Avenue
ersey City, NJ 07306
201) 795-4555

DDLESEX

r. Robert McCarthy, Dir
iddlesex Co. Dept. of
olid Waste Mgt. Programs
0 Bayard Street
w Brunswick, NJ 08901
201) 745-4170

EAN

. Ernie Kuhlwein
lid Waste Coordinator
ean Co. Planning Board
urt House Annex C.N. 2191
ms River, NJ 08753
01) 929-2054

MERSET

. John Hornsky, S.W. Mgt.
fice of Solid Waste Mgt.
O. Box 3000
merville, N.J. 08876
01) 231-7031

RREN

. Russell Miles, Pln. Dir.
rren Co. Planning Board
ount Administration Bldg.
lvidere, N.J. 07823
01) 475-6531 [Bart Carrera-(201) 453-7374]

BERGEN

Mr. James Battaglia, Director
Solid Waste Mgt. Div. of Bergen
County Util. Auth.
Foot of Mehrhof Road
Little Ferry, NJ 07643
(201) 641-2552

CAPE MAY

Mr. Thomas Broncich
Solid Waste Manager
Cape May Mun. Util. Auth.
P.O. Box 610
Cape May Court House, NJ 08210
(609) 465-9026

GLOUCESTER

Robert Scalpino
Gloucester Co. Planning Dept.
County Building
Delsea Drive
Clayton, NJ 08312
(609) 863-6661

HUNTERDON

Ms. Teresa Martin, Director
Solid Waste-Recycling Dept.
County of Hunterdon
Co. Adm. Bldg. 1 East Main St.
Flemington, NJ 08822
(201) 788-1110

MONMOUTH

Mr. Lawrence Zaayenga
Solid Waste Coordinator
Monmouth Co. Planning Board
Hall of Records Anx.Box 1255
Freehold, N. J. 07728-1255
(201) 431-7460

PASSAIC

Mr. James D. Rogers
Planning Director
Passaic County Utilities Authy.
Admin. Bldg., 317 Penna. Ave.
Paterson, NJ 07503
(201) 881-4490

SUSSEX

Mr. Fred Suljic, Planning Dir.
Dept. Plan. Conser. & Eco. Dev.
Sussex County, 55-57 High St.
Newton, New Jersey 07860
(201) 383-2820

BURLINGTON

Mr. Robert Simkins
Supv., Off. of Waste Mgt.
Burlington Co. Health Dept.
49 Rancocas Road
Mount Holly, NJ 08060
(609) 499-1001

CUMBERLAND

Mr. Larry Klock
Solid Waste Coord.
Cumberland Co. Improv. Auth.
2 West Vine Street
Millville, NJ 08332
(609) 825-3700

H.M.D.C.

Mr. Thomas Marturano
Director of Solid Waste
Hackensack Meadowlds Dev. Comm.
One DeKorte Park Plaza
Lyndhurst, NJ 07071
(201) 460-1700

MERCER

Mr. Lauren Moore
S.W. Supervisor
Mercer Co. Improvement Auth.
1589 Lamberton Rd.
Trenton, NJ 08611
(609) 695-1200

MORRIS

Mr. Glenn Schweizer
Solid Waste Coordinator
Morris Co. Mun. Utilities Aut.
Courthouse, CN900
Morristown, NJ 07960
(201) 285-8390

SALEM

Mr. William Godfrey
Salem Co. Utilities Auth.
P. O. 674
McKillip Road.
Alloway, N. J. 08001-0674
(609) 935-7900

UNION

Mr. Joseph Kazar, Director
Union County Utilities Auth.
24-52 Rahway Avenue
Elizabeth, N.J. 07207
(201) 351-8770

PORT AUTHORITY OF NY & N

Mr. Richard Cronin
Port Authority of N.Y & N.J.
One World Trade Center
New York, N.Y. 10048

NLI 002 1027

Pottstown Landfill
Ind Road
Pottstown Pennsylvania 19464
215 327-2700

Waste Management

SOILS CONTAMINATED WITH MISCELLANEOUS SUBSTANCES
(PCBs, Waste Oil, etc.

1. Analytical Parameters:
   Module 1 list
   Full TCLP
   Total Petroleum Hydrocarbons
   PCBs

** Unknown source of spill or abandoned facilities also require a VOA (volatile scan).

2. Module 1 Application:
   -Schematic of Soil Area (include buildings, roads, etc.)
   -Sampling Description - how composites were taken

   * $200.00 Review Fee - DER requires $200.00 submittal fee in order to review module application. Check should be payable to "Pottstown Landfill".

3. Waste Management Forms:
   "Type A" Profile (WMNA-0089A)
   Contractor's Definition of Special Waste (WMNA-0038AD)
   Certificate of Representative Sample (WMNA-0089C)

****
NOTE:
Generators disposing of over 500 cubic yards of contaminated soil must have the Module 1 parameters run on one composite sample for every 500 yards of soil. (Example: A generator with 750 cubic yards of soil must have parameters run on two (2) composite samples.)
****

NLI 002 1028

PENNSAUKEN SOLID WASTE MANAGEMENT AUTHORITY

9600 RIVER ROAD · PENNSAUKEN, NEW JERSEY 08110 · 609-663-[illegible] · 609-663-2664

JOHN E. JACOBS, Executive Director
WILLIAM R. BURLINGTON, President
TERRENCE M. CARR, Vice President
ROBERT G. CORNFORTH, Secretary
CARL R. BIERBACH, Treasurer
PATRICK T. CORBETT, Assistant Secretary

REQUIREMENTS FOR DISPOSAL OF ID 27 WASTE AT THE PENNSAUKEN SANITARY LANDFILL

1) The waste material must be classified as ID 27 by means of a letter issued from the NJ State Department of Environmental Protection, Division of Hazardous Waste Management. Representative sample(s) will be required in order for the DEP to make the classification. The minimum sampling requirement by the DEP is one (1) sample per 100 cubic yards of material.

2) PSWMA reserves the right to require additional sampling, as required, to determine the extent of contamination to the soil. Our intent is to use the ID 27 as cover material for the landfill, where the concentration of pollutants are minimal.

3) The laboratory analyses performed on the waste material must include the proper quantity of samples and be analyzed for the following parameters:

   a. Total petroleum hydrocarbons.

   b. EP Toxicity for metals including Chromium, Arsenic, Selenium, Mercury, Barium, Lead. Cadmium and Silver.

   c. Reactivity to Cyanide.

   d. Reactivity to Sulfide.

   e. Total PCB's if the total petroleum hydrocarbons exceed 50 ppm.

   f. Priority Pollutant Analyses with the exception of PCB's and metals on 20% of the highest TPH'S exceeding 1,000 ppm.

4) The applicant for disposal of ID 27 shall submit a cover letter addressed to the PSWMA, 9600 River Road, Pennsauken, New Jersey 08110, Attention: Operations Manager, with the following information included:

NLI 002 1029

Name of Owner:

Location of Property:

Contractor To Be Used For Hauling:

Quantity of Material:

In addition, a copy of the NJ DEP Classification Letter and Lab Analyses shall be attached to the cover letter.

5) PSWMA reserves the right to take the following action with regard to waste material:

a. Accept material based on initial review.

b. Require access to the site and material, and take random samples of the soil for analysis by an independent laboratory chosen by PSWMA. All sampling and analyses must be paid for by the applicant.

c. Refuse to accept material based on unacceptable limits of parameters which may be unsuitable for cover material at the landfill.

6) In all cases, a letter of approval from PSWMA is required for the disposal of all ID 27 at the Pennsauken Sanitary Landfill.

NOTE: The Maximum Concentration Limits established by the State of NJ for metals, will generally follow the informal ECRA guidelines for soils. The maximum concentration of Total Petroleum Hydrocarbons for any sample is 1000 ppm. (This requirement exceeds the limit established by the State.) The presence of PCB's, herbicides and/or pesticides will be analyzed in conjunction with the complete contaminants presence and quantity of material proposed for disposal.

PSWMA reserves the right to reject any material which could be hazardous to our stormwater runoff which is sampled regularly as required by our NJ State DEP, DSW Permit.

(Rev. July 1991)

INSTRUCTIONS FOR COMPLETING MODULE 1

REQUEST FOR APPROVAL TO TREAT, STORE, OR DISPOSE OF A HAZARDOUS OR RESIDUAL WASTE STREAM

Form ER – WM – 141

Important: Read all instructions *carefully* before completing module and submit only one waste stream per module.

SECTION I - GENERAL INFORMATION - self explanatory.

SECTION II - WASTE DESCRIPTION

Item A General Properties

#3. Describe the color and odor of the waste. (This question is subjective.) For example, gray, solvent odor. Enter number of solid or liquid phases of separation and describe each phase. For example, 2 phases of separation, one solid and one liquid.

#4. Provide the proper U.S. DOT shipping name, UN/NA number and hazard class for the waste stream. For example, solvents, waste, n.o.s. (toluene, MEK, butanol), UN 1993, flammable.

#8. a. Check yes if the waste stream is a hazardous waste as described in Chapter 261.

b. If yes, describe the waste by its characteristic (Chapter 261, Subchapter C), the nonspecific or specific source lists (261.31 and 261.32), and/or the commercial chemical product or manufacturing chemical intermediate lists (261.33(e) and 261.33(f)). List all the reasons which cause the waste to be hazardous. For example, spent pickle liquor from steel finishing operations, K062, Corrosive (D002), and Toxicity Characteristic (D007).

Item B. Chemical Analyses

These analyses and tests must be performed for all treatment and disposal activities except incineration and thermal treatment. Activities utilizing surface impoundments and waste piles for storage are also required to perform these tests and analyses. Analytical requirements for incineration and thermal treatment can be obtained by contacting the Department.

All analyses submitted must specify the method used and any special preparation, deviation from the method, or pertinent observations. A list of accepted methods is available from the Department. The Method of Standard Addition must be employed to take into account interferences in the matrix of the sample. See the current edition of EPA's *Test Methods for Evaluating Solid Waste* (SW-846) or *Standard Methods for Examination of Water and Wastewater.*

The laboratory performing the analysis must employ the quality control procedures described in EPA's *Test Methods for Evaluating Solid Waste* (SW-846). The procedures and documentation of the quality control procedures must be available for inspection if requested by the Department.

#1. Total Analysis of the Waste - This analysis must include the following list of parameters (a-n) unless generator certifies in writing the absence of the parameters based on his knowledge of the manufacturing or pollution control processes. Additional parameters, if necessary, must analyzed to completely characterize the waste. Each analysis sheet must include: *date of sampling, date of analysis, name of laboratory performing test,* and *laboratory contact person* and *phone number.* Analytical determinations should be run on the samples as is, unless otherwise specified in the cited method. Report the analyses in mg/kg on a dry weight basis for solids or in mg/L for liquids, or as otherwise specified in cited method.

No single analytical method is applicable for all waste streams and some modifications may be necessary for unusual waste types. Any modifications, however, must be approved by the Department.

If the sample is of unknown origin or characteristics contact the Department at 215-832-6212 prior to analysis.

Recycled Paper

NLI 002 1031

a. Solids

i. Total Solids

ii. Total Volatile Solids

iii. Total Dissolved Solids

b. Free Liquids

c. pH

d. Cyanide

e. Oil and Grease and/or Total Petroleum Hydrocarbons

f. Total Organic Halogen

g. Ammonia-Nitrogen - Liquids Only

h. Phenolics - Liquids Only

i. Total Metals

i. Arsenic

ii. Barium

iii. Cadmium

iv. Chromium

v. Lead

vi. Mercury

vii. Nickel

viii. Selenium

ix. Silver

x. Copper

xi. Zinc

j. Organics - Wastes must be tested for specific solvents, pesticides, or other organic constituents known to be used or produced as a product or byproduct in the process that generated the waste stream. For methods of analysis for specific compounds refer to EPA's *Test Methods for Evaluating Solid Waste* (SW-846), or other published procedures. Other methods or modifications may be acceptable if approved by the Department. Contact the Department at (717) 787-7381 for such approval.

Note: If the results of the Total Organic Halogen determinations in f are less than 50 mg/kg, analysis for particular halogenated organic compounds is not required, unless specified by the Department.

k. Heating Value

l. Ignitability

m. Corrosivity

n. Reactivity (Including Reactive Cyanide and Reactive Sulfide) or submit certification that waste is not reactive.

#2 Toxicity Characteristics Determinations

To demonstrate a waste stream is or is not hazardous by toxicity characteristics, use the Toxicity Characteristic Leaching Procedure (TCLP) for parameters listed in 261.24(b) and 40 CFR 261.[illegible] The analyses should be conducted on samples in the condition in which they are to be treated, stored or [illegible]posed.

The following constituents and parameters are required in the leachate analysis unless they are not present in the total analysis, or if the total analysis of the waste indicates less than the Maximum Concentration of Contaminants for the parameters listed in 261.24(b), or 100 times the EPA Interim Primary Drinking Water Standards for a given constituent or parameter, then that constituent or parameter need not be analyzed unless otherwise specified by the Department. Report all results in mg/L or as otherwise specified in methods.

a. Extract fluid pH, report as pH units

b. pH - in leachate, report as pH units

c. Phenolics

c. Total Metals

  i. Antimony

  ii. Arsenic

  iii. Barium

  iv. Cadmium

  v. Chromium

  vi. Hexavalent Chromium

  vii. Lead

  viii. Mercury

  ix. Nickel

  x. Selenium

  xi. Silver

  xii. Copper

  xiii. Zinc

e. Organics - for methods of analysis for specific compounds, refer to EPA's ***Test Methods for Evaluating Solid Waste*** (SW-846), or other published procedures. Other methods may be acceptable if approved by the Department.

   Unless otherwise specified by the Department, if the value of Total Organic Carbon in #3b is less than 50 mg/L, ananalysis for particular organic compounds is not required; if the value for Total Organic Halogen in #3c is less than 50 mg/L, analysis for particular halogenated organic compounds is not required.

#3. Water Leaching Determinations

Use the extraction procedure described in ASTM Method D3987-85 for the following constituents and parameters. The analysis should be conducted on samples in the condition in which they are to be treated, stored or disposed. Report all results in mg/L or as otherwise specified in method.

a. pH

b. Total Organic Carbon

c. Total Organic Halogen

NLI 002 1033

(TCLP)

TABLE A
Maximum Concentration of Contaminants
For Toxicity Characteristic (TC)

	Reg. Level (mg/l)
Arsenic	5.0
Barium	100.0
Benzene	0.5
Cadmium	1.0
Carbon Tetrachloride	0.5
Chlordane	0.03
Chlorobenzene	100.0
Chloroform	6.0
Chromium	5.0
o-Cresol	200.0
m-Cresol	200.0
p-Cresol	200.0
Cresol	200.0
2,4-D	10.0
1,4-Dichlorobenzene	7.5
1,2-Dichloroethane	0.5
1,1-Dichloroethylene	0.7
2,4-Dinitrotoluene	0.13
Endrin	0.02
Heptachlor (and hydroxide)	0.008
Hexachlorobenzene	0.13
Hexachlorobutadiene	0.5
Hexachloroethane	3.0
Lead	5.0
Lindane	0.4
Mercury	0.2
Methoxychlor	10.0
Methyl Ethyl Ketone	200.0
Nitrobenzene	2.0
Pentachlorophenol	100.0
Pyridine	5.0
Selenium	1.0
Silver	5.0
Tetrachloroethylene	0.7
Toxaphene	0.5
Trichloroethylene	0.5
2,4,5-Trichlorophenol	400.0
2,4,6-Trichlorophenol	2.0
2,4,5-TP Silvex	1.0
Vinyl Chloride	0.2

d. Ammonia - Nitrogen

e. Oil and Grease

f. Cyanide

g. Chemical Oxygen Demand

h. Solids

i. Total Solids

ii. Total Volatile Solids

iii. Total Dissolved Solids

#4. Description of the sampling method - The procedures outlined in 261.34(a) must be followed when sampling waste streams.

Item C. Process Description and Schematic - Please attach to this module the following:

#1. Confidentiality claim (if any) - Information submitted to the Department in this portion of the module may be claimed as confidential by the applicant. If no claim is made at the time of submission, the Department shall make the information available to the public without further notice.

Claim of confidentiality shall address the following:

a. The portions of the information claimed to be confidential.

b. The length of time the information is to remain confidential.

c. The measures taken to guard undesired disclosure of the information to others.

d. The extent the information has been disclosed to others and the precautions taken in connection with that disclosure.

e. A copy of pertinent confidentiality determinations by EPA or any other federal agency.

f. The nature of the substantial harm to the competitive position by disclosure of the information, the reasons it should be viewed as substantial and the relationship between the disclosure and the harm.

#2. Describe the manufacturing process which produced the waste and any pollution control methods involved. This must include the raw materials used in the process, any intermediate products formed, final products, and any substances added during treatment. For example:

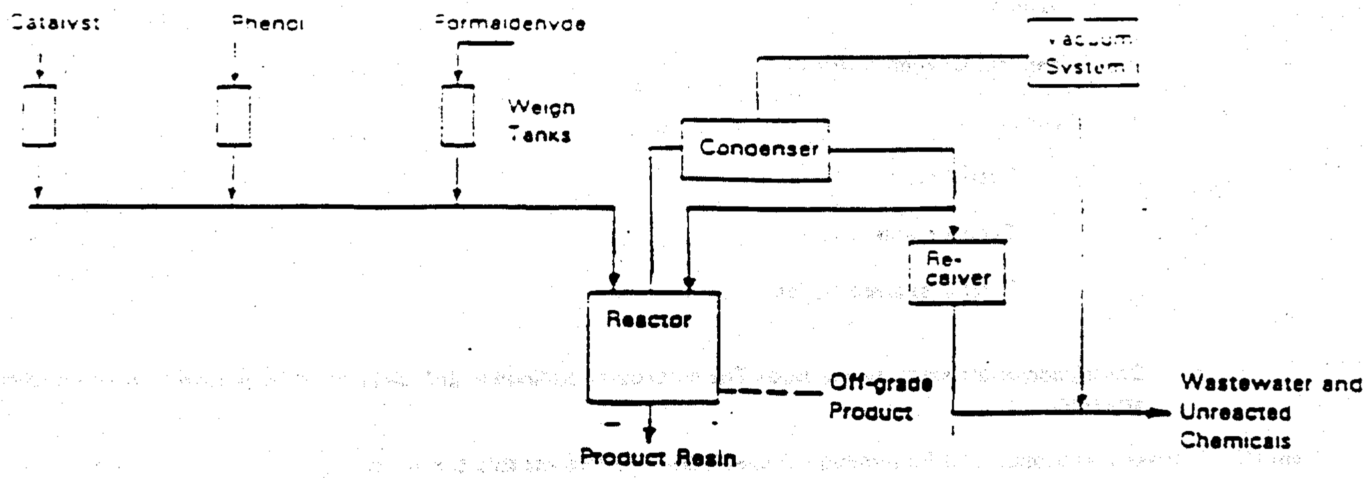
"Resol Resin Manufacture"

"These resins are formed by reacting phenol, or a substituted phenol with formaldehyde which contains an excess of formaldehyde. An alkali (sodium hydroxide) is used to catalyze the polymerization which takes place at a pH of between 8 and 11 and at a temperature of 60°C.

"When the desired degree of polymerization has occurred, the kettle is cooled to about 35°C to inhibit further reaction. The caustic may be neutralized in the kettle with sulfuric acid at this time. The water from this distillation forms a concentrated waste of unreacted materials and low molecular weight resin.

"The batch is dumped, and depending on the specific resin, the batch may be washed several times and a vacuum may be used during the dehydration cycle. It is important that molten resin be handled quickly to avoid its setting up to an insoluble, infusible mass, which would become a waste."

#3 Provide, on 8½" x 11" size paper, flow schematics of the manufacturing and/or pollution control processes generating the hazardous or residual waste stream starting with the raw materials and ending with the final products. For example:



NLI 002 1036

Liner compatibility testing - any facility utilizing a liner must conduct an evaluation of the liner compatibility with the waste stream before accepting that waste stream for storage, treatment or disposal in a waste pile, surface impoundment, landfill unless the approval to accept that waste stream is granted in the facility's permit. The evaluation procedure must be approved by the Department prior to its commencement.

The test protocol will vary with the type of liner system and the characteristics of the waste stream. The Department should be contacted for appropriate test protocols. In lieu of actual testing, existing published or documented data on the hazardous waste or waste generated from similar processes proving the liner compatibility may be substituted in some instances.

SECTION IV — PROPOSED TREATMENT, STORAGE, OR DISPOSAL METHOD

Use additional sheets of paper if necessary.

Item A. Proposed Treatment Method - If applicable, briefly describe the method proposed to treat this waste stream. For example, "Solvent removed from waste by solvent recovery apparatus to less than 1% solvent. Recovered solvent is sold to XYZ, Inc. for reclamation. Solids are polymerized and the remaining solvent is driven off by heat."

Item B. Proposed Storage Method - If applicable, briefly describe the method proposed to store this waste stream and the compatibility with its container, the waste pile liner, or the surface impoundment liner. For example, "Paint waste is placed into 55 gal. steel drums and is proposed to be stored at the XYZ Waste Disposal Company's storage building for 60 days prior to processing. The paint waste is compatible with its container and the other wastes stored in the immediate vicinity. The proposed location for the paint waste within the building is indicated on the attached drawing."

Item C. Proposed Disposal Method - If applicable, briefly describe the method proposed to dispose of this waste stream. For example, "Polymerized solids are to be placed in a segregated cell of XYZ Waste Disposal Company with compatible wastes as indicated on the attached drawing. The cell is located at coordinates D-7. The cell design has been approved as part of the facility permit."

SECTION V. ALTERNATIVES TO PROPOSED TREATMENT AND/OR DISPOSAL METHOD

Item A. What Other Treatment, Disposal, Recycle, Reuse, or Reclaim Method(s) Can be Used? Briefly describe viable alternatives to your proposal.

Item B. Why was the Treatment and/or Storage Disposal Method in Section III Chosen? Briefly describe why the proposed method was chosen. For example, "The proposed method offers the most cost effective means of disposal over a 10 year period. Capital investment of solvent apparatus and polymerization equipment will be off-set by income from sale of recovered solvent and smaller volumes of waste to be disposed."

SECTION VI. CERTIFICATION OF GENERATOR

The Application Must be Certified in the Following Manner:

#1. Corporation - A corporate officer must sign the document and the corporate seal must be affixed.

#2. Limited partnerships - A general partner must sign the document.

#3. All other partnerships - A partner must sign the document.

#4. Sole proprietorships - The proprietor.

#5. Municipal, state, or federal authority or agency - An executive officer or ranking elected official responsible for compliance of the authority's or agency's hazardous waste activities and facilities with all applicable regulations.

All signatures affixed to the document must be notarized.

SECTION VII. CERTIFICATION OF REGISTERED PROFESSIONAL ENGINEER FOR TREATMENT, STORAGE, OR DISPOSAL FACILITY — Self-Explanatory.

ER-WM-14: REV. 12/85

PA DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF WASTE MANAGEMENT
MODULE 1

DATE PREPARED ______

DATE REVISED ______

DEPARTMENT USE ONLY

REQUEST FOR APPROVAL TO TREAT, STORE, OR DISPOSE OF A HAZARDOUS OR RESIDUAL WASTE STREAM

SEE INSTRUCTIONS BEFORE COMPLETING THIS FORM

I. GENERAL INFORMATION (must be completed by TSD facility)

A. Treatment, Storage, or Disposal Site

1. Name of facility Waste Management - Pottstown Landfill

   Address Sell Road Pottstown, PA 19464

   Municipality West Pottsgrove Twp. County Montgomery

2. Identification number (if applicable) [illegible]

3. Solid waste permit number(s) for treatment, storage or disposal facility to be utilized PADER Permit #100549

4. Facility contact person

   Name DAVID A. HEFFNER Title LABORATORY MANAGER

   Phone no. (215) 327-2708

B. Generator of the Waste

1. Name of company ______

   Mailing address ______

   Location of site if different from mailing address ______

   Municipality ______ County ______

2. If a subsidiary, name of parent co. ______

3. Identification number (if applicable) ______

4. Company contact person

   Name ______ title ______

   Phone no. ______

NLI 002 1038

DATE PREPARED

DATE REVISED

DEPARTMENT USE ONLY

WASTE DESCRIPTION (Must be completed by Generator)

A. General Properties

1. pH range ______ to ______ (based on past analyses or knowledge)

2. Physical state:

a. ☐ liquid (less than 20% solids by dry wt. or flowable)

b. ☐ gas (ambient temperature and pressure)

c. ☐ solid (equal to or greater than 20% by dry wt. and non-flowable)

d. ☐ Check here if c. above was checked and waste contains free liquids.

3. Physical appearance:

Color ______ Odor ______

Number of solid or liquid phases of separation ______

Describe each phase of separation

4. U.S. DOT proper shipping name UN/NA number, and hazard class (if applicable):

5. Typical volume of waste to be shipped to treatment storage or disposal facility:

a. Monthly ______ gal., tons (circle one)

b. Annually ______ gal., tons (circle one)

6. Treatment or disposal frequency: ______ times per year; ☐ one time

7. Current volume to be shipped to treatment storage or disposal facility ______ gal., tons (circle one)

8. a. Is the waste a hazardous waste as defined in 75.261? ☐ Yes ☐ No

b. If yes, describe the hazardous waste according to its description and hazardous waste number in 75.261.

9. Has the waste been delisted as a hazardous waste by DER? ☐ Yes ☐ No ☐ N/A
If yes or N/A, check the appropriate box(es) in Item 10.

DATE PREPARED

DATE REVISED

DEPARTMENT USE ONLY

10. Is the waste a residual waste or a delisted hazardous waste? ☐ Yes ☐ No
If yes, check the following box(es) as applicable:

☐ discarded commercial chemical product
☐ tank bottom
☐ off-specification species
☐ manufacturing chemical intermediate
☐ still bottom
☐ spent catalyst
☐ flyash
☐ bottom ash
☐ slag
☐ foundry sand
☐ SO_2 scrubber sludge
☐ process waste
☐ infectious waste
☐ bagnouse dust
☐ wastewater treatment plan residue (industrial)
☐ wastewater treatment plant residue (sewage)
☐ water treatment plant residue
☐ incinerator residue
☐ acid mine drainage treatment sludge
☐ spill residue
☐ other (specify) ______

B. Chemical Analyses — *Please attach the following:*
1. The results of the total analysis of the waste as described in the instructions.
2. The results of the leaching tests as described in the instructions and the leaching method.
3. A description of the sampling method.
4. The range of concentrations of the constituents based on knowledge or past analyses.

C. Process Description and Schematic — *Please attach the following:*
1. The substantiation for a confidentiality claim as described in the instructions, if portions of the information you have submitted are confidential.
2. A detailed description of the manufacturing and/or pollution control processes producing the hazardous or residual waste as specified in the instructions.
3. A schematic of the manufacturing and/or pollution control processes producing the hazardous or residual waste as specified in the instructions.

III. Liner Compatibility Evaluation (must be completed by TSD facility)

Attach the results of the liner compatibility evaluation or supporting data as specified in the instructions.

This material will be disposed of in the double-lined areas of the landfill. This system consists of two 60 mil. HDPE geomembrane liners, which have shown to be compatible with similar wastes. The leachate is collected and directed to the landfill's pretreatment facility, and ultimately discharged to the Pottstown Waste Water Treatment Plant.

NLI 002 1040

DATE PREPARED

DATE REVISED

DEPARTMENT USE ONLY

IV. PROPOSED TREATMENT, STORAGE, AND/OR DISPOSAL METHOD (must be completed by TSD facility. Use additional sheets if necessary.)

A. Proposed Treatment Method

Treatment not required.

B. Proposed Storage Method and Length of Storage

None

C. Proposed Disposal Method

Co-dispose with municipal refuse.

V. ALTERNATIVES TO PROPOSED TREATMENT AND/OR DISPOSAL METHOD (must be completed by generator. Use additional sheets if necessary.)

A. What Other Treatment, Disposal, Recycle, Reuse, or Reclamation Method(s) Can be Used? Briefly describe viable alternatives to your proposal.

B. Why was the Treatment and/or Disposal Method in Section IV Chosen?

NLI 002 1041

DATE PREPARED ____________

DATE REVISED ____________

MODULE 1 PAGE 3

FOR DEPARTMENT USE ONLY

VI. CERTIFICATION OF GENERATOR

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based upon my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

Name of Responsible Official ____________________ Title ____________

Signature ____________________ Date ____________

Taken, sworn and subscribed before me, this

NOTARY SEAL

______ day of ____________ A.D. 19 ____

____

____

VII. CERTIFICATION OF REGISTERED PROFESSIONAL ENGINEER FOR TREATMENT STORAGE AND/OR DISPOSAL FACILITY

This is to certify that I have personally reviewed all engineering information contained in the accompanying modules, drawings, specifications, and other documents which are part of this application and that I have found it to be of good engineering quality, true and correct, and is in conformance with the requirements of the Department of Environmental Resources, and it does not, to the best of my knowledge, withhold information that is pertinent to a determination of compliance with the requirements of the Department.

NOTICE: It is an offense under Pennsylvania Crimes Code to affirm a false statement in documents submitted to the Department.

Name ____________________

Signature ____________________

Date ____________

Address ____________________

____

Phone No. ____________

SEAL OF PA REGISTERED PROFESSIONAL ENGINEER

APPENDIX K

WELL POINT SYSTEM INFORMATION

MORETRENCH AMERICAN CORPORATION

dewatering systems and services

TELEX: 136-446, MORETRNCH ROCA

ADDRESS REPLY TO:

P.O. BOX 316
ROCKAWAY, NEW JERSEY

February 14, 1984

N. L. Industries, Inc.
P. O. Box 1090
Hightstown, N. J. 08520

Attention: Mr. W. K. Widdendorf

Reference: Groundwater Abatement System - National Smelting of N.J.
Pedricktown, N. J. ---- Well Record

Gentlemen:

Enclosed you will find completed well record reports for Permit Nos. 30-3149 through and including 30-3199. Additional permits, Nos. 30-3200 through 30-3203, were issued by the Division of Water Resources, but the wells were not installed.

The forms were supplied by the State of New Jersey, Division of Water Resources.

I apologize for the tardiness of this paperwork. We trust it will satisfy the State of New Jersey's requirements.

Very truly yours,

MORETRENCH AMERICAN CORPORATION

Joseph McCann

Joseph McCann
Vice President

JMcC/eg

enclosures

cc:Mr. Delaney

RECEIVED
FEB 15 1984
ENVIRONMENTAL CONTROL

NLI 002 1044

Form DWR-138
1/30

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTEC
DIVISION OF WATER RESOURCES

PERMIT NO 30-3164

APPLICATION NO

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. NE 1 SURFACE ELEVATION ______ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/7/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet; Bottom --23-- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter ______ Inches Length -- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at -- Feet above surface

Water rises to ---- Feet above surface

8. RECORD OF TEST: Date 10/9/83 Yield four Gallons per minute

Static water level before pumping ten Feet below surface

Pumping level thirteen feet below surface after one hours pumping

Drawdown three Feet Specific Capacity 1.33 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at three feet.

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-MetPro Corp.

Capacity 400 G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

~~Depth of Pump in well ______ Feet~~ Depth of Footpiece in well -- Feet

at surface ~~Depth of Air Line in well ______ Feet~~ Type of Meter on Pump micrometer Size 6-- Inches

10. USED FOR ground water abatement AMOUNT { Average four Gallons Daily; Maximum eight Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ____ No ____.

Taste -- Odor -- Color --- Temp. ____ °F.

12. LOG see over please Are samples available? ______
(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA --

14. DATA OBTAINED BY -- Date --

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1045

Form DWR-128
11/80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECT
DIVISION OF WATER RESOURCES

23451
PERMIT NO [illegible]

APPLICATION NO

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. NE 2 SURFACE ELEVATION ____ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/7/83 DRILLER Moretrench American Cor

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet, Bottom --23-- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter ____ Inches Length -- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at -- Feet above surface

Water rises to ---- Feet above surface

8. RECORD OF TEST: Date 10/9/83 Yield four Gallons per minute

Static water level before pumping ten Feet below surface

Pumping level thirteen feet below surface after one hours pumping

Drawdown three Feet Specific Capacity 1.33 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at three feet.

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-MetPro Corp.

Capacity 400 G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

~~Depth of Pump in well ____ Feet~~ Depth of Footpiece in well -- Feet

at surface ~~Depth of Air Line in well ____ Feet~~ Type of Meter on Pump micrometer Size 6-- Inches

10. USED FOR ground water abatement AMOUNT { Average four Gallons Daily, Maximum eight Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste -- Odor -- Color --- Temp. ____ °F.

12. LOG see over please Are samples available? ____

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA --

14. DATA OBTAINED BY -- Date --

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1046

DWR-138
80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTEC
DIVISION OF WATER RESOURCES

PERMIT NO. [illegible]

APPLICATION NO.

COUNTY Salem

WELL RECORD

OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. NE 3 SURFACE ELEVATION ______ Feet (Above mean sea level)

1. LOCATION Lot: 2-17 Block: 17 Municipality: Oldmans Twp.

2. DATE COMPLETED 10/7/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth: Top twenty Feet; Bottom --23-- Feet

Geologic Formation Cape May Formation

Tail Piece: Diameter ______ Inches Length -- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at -- Feet above surface

Water rises to ---- Feet above surface

8. RECORD OF TEST: Date 10/9/83 Yield four Gallons per minute

Static water level before pumping ten Feet below surface

Pumping level thirteen feet below surface after one hours pumping

Drawdown three Feet Specific Capacity 1.33 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at three feet.

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-MetPro Corp.

Capacity 400 G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

Depth of Pump in well ______ Feet Depth of Footpiece in well -- Feet

Surface Depth of Air Line in well ______ Feet Type of Meter on Pump micrometer Size 6 -- Inches

10. USED FOR ground water abatement AMOUNT: Average four Gallons Daily; Maximum eight Gallons Daily

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste -- Odor -- Color --- Temp. ____ °F.

12. LOG see over please Are samples available? ______

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA --

14. DATA OBTAINED BY -- Date --

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1047

Form DWR-138
11/80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

PERMIT NO [illegible]

APPLICATION NO

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. NE 4 SURFACE ELEVATION Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/7/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth: Top twenty Feet; Bottom --23-- Feet. Geologic Formation Cape May Formation

Tail Piece: Diameter Inches Length -- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at -- Feet above surface

Water rises to ---- Feet above surface

8. RECORD OF TEST: Date 10/9/83 Yield four Gallons per minute

Static water level before pumping ten Feet below surface

Pumping level thirteen feet below surface after one hours pumping

Drawdown three Feet Specific Capacity 1.33 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at three feet.

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-MetPro Corp.

Capacity 400 G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

~~Depth of Pump in well~~ Feet Depth of Footpiece in well -- Feet

surface ~~Depth of Air Line in well~~ Feet Type of Meter on Pump micrometer Size 6-- Inches

10. USED FOR ground water abatement AMOUNT: Average four Gallons Daily; Maximum eight Gallons Daily

11. QUALITY OF WATER not tested Sample: Yes No

Taste -- Odor -- Color --- Temp. °F.

12. LOG see over please Are samples available?
(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA --

14. DATA OBTAINED BY -- Date --

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1048

Form DWR-132
80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

PERMIT NO. ____

APPLICATION NO. ____

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. NE 5 SURFACE ELEVATION ____ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/5/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two inches Length three Feet

Range in Depth: Top twenty Feet; Bottom ---23--- Feet. Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY No Gallons per minute at --- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/7/83 Yield three Gallons per minute

Static water level before pumping ---ten ---- Feet below surface

Pumping level 12.5 feet below surface after 1.5 hours pumping

Drawdown 2.5 Feet Specific Capacity one Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at 2.5

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-Metro Corp.

Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

at surface

Depth of Pump in well ____ Feet Depth of Footpiece in well --- Feet

Depth of Air Line in well ____ Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT: Average three Gallons Daily; Maximum ten Gallons Daily

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste ____ Odor ____ Color ____ Temp. ____ °F.

12. LOG see over please Are samples available? ____

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1049

Form DWR-128
80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTEC
DIVISION OF WATER RESOURCES

Record: 2451

PERMIT NO _______

APPLICATION NO. _______

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SME IG OF NJ ADDRESS PENNSVILLE PEDRICKT RD.

Owner's Well No. NE 6 SURF E ELEVATION _______ Feet (Above mean sea le)

2. LOCATION Lot: 2 Block 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 83 DRILLER Moretrench American Cor

4. DIAMETER: Top 1-1/2 Bottom two inches TOTAL DEPTH twenty-t Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length 3ty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth: Top twenty Feet; Bottom ---23--- Feet

Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY No Gallons per minute at --- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/7/83 Yield three Gallons per minute

Static water level before pumping ---ten ---- Feet below surface

Pumping level 12.5 feet below surface after 1.5 hours pumping

Drawdown 2.5 Feet Specific Capacity one Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at 2.5

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-Metro Corp.

Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

at surface

Depth of Pump in well _______ Feet Depth of Footpiece in well -- Feet

Depth of Air Line in well _______ Feet Type of Meter on Pump micrometer six Inches

10. USED FOR ground water abatement AMOUNT: Average three Gallons Daily; Maximum ten Daily

11. QUALITY OF WATER not tested Sample: Yes ___ No ___

Taste ___ Odor ___ Color ___ Temp. ___ °F.

12. LOG see over please Are samples available? ___

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1050

DWR-128
80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTEC
DIVISION OF WATER RESOURCES

Record: 0020451

PERMIT NO [illegible]

APPLICATION NO

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. NE 7 SURFACE ELEVATION ______ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/5/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet; Bottom ---23--- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY No Gallons per minute at --- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/7/83 Yield three Gallons per minute

Static water level before pumping ---ten ---- Feet below surface

Pumping level 12.5 feet below surface after 1.5 hours pumping

Drawdown 2.5 Feet Specific Capacity one Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at 2.5

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-Metro Corp.

Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

at surface ~~Depth of Pump in well~~ ______ Feet Depth of Footpiece in well --- Feet

~~Depth of Air Line in well~~ ______ Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT { Average three Gallons Daily; Maximum ten Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste ______ Odor ______ Color ______ Temp. ______ °F.

12. LOG see over please Are samples available? ______

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1051

Form DWR-138
11/80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

Coord: 0022451
PERMIT NO [illegible]
APPLICATION NO. ______
COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. NE 9 SURFACE ELEVATION ______ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/5/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth: Top twenty Feet; Bottom ---23--- Feet Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY No Gallons per minute at --- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/7/83 Yield three Gallons per minute

Static water level before pumping ---ten---- Feet below surface

Pumping level 12.5 feet below surface after 1.5 hours pumping

Drawdown 2.5 Feet Specific Capacity one Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at 2.5

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-Metro Corp.

Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

at surface

Depth of Pump in well ______ Feet Depth of Footpiece in well --- Feet

Depth of Air Line in well ______ Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT: Average three Gallons Daily; Maximum ten Gallons Daily

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste ______ Odor ______ Color ______ Temp. ______ °F.

12. LOG see over please Are samples available? ______

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1052

Form DWR-138
[illegible]

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTEC
DIVISION OF WATER RESOURCES

Record: [illegible]
PERMIT NO [illegible]
APPLICATION NO
COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. NE 8 SURFACE ELEVATION Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/5/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth: Top twenty Feet; Bottom ---23--- Feet

Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY No Gallons per minute at --- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/7/83 Yield three Gallons per minute

Static water level before pumping ---ten ---- Feet below surface

Pumping level 12.5 feet below surface after 1.5 hours pumping

Drawdown 2.5 Feet Specific Capacity one Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at 2.5

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-Metro Corp.

Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

at surface

Depth of Pump in well Feet Depth of Footpiece in well --- Feet

Depth of Air Line in well Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT: Average three Gallons Daily; Maximum ten Gallons Daily

11. QUALITY OF WATER not tested Sample: Yes No

Taste Odor Color Temp. °F.

12. LOG see over please Are samples available?

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1053

Form DWR-138
11/80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTEC
DIVISION OF WATER RESOURCES

[illegible]: 2023451

PERMIT NO [illegible]

APPLICATION NO ______

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. NE 10 SURFACE ELEVATION ______ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Bl[illegible]: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/5/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth: Top twenty Feet; Bottom ---23--- Feet

Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY No Gallons per minute at --- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/7/83 Yield three Gallons per minute

Static water level before pumping ---ten ---- Feet below surface

Pumping level 12.5 feet below surface after 1.5 hours pumping

Drawdown 2.5 Feet Specific Capacity one Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at 2.5

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-Metro Corp.

Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

at surface

Depth of Pump in well ______ Feet Depth of Footpiece in well --- Feet

Depth of Air Line in well ______ Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT: Average three Gallons Daily; Maximum ten Gallons Daily

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste ______ Odor ______ Color ______ Temp. ______ °F.

12. LOG see over please Are samples available? ______
(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

NLI 002 1054

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

Form DWR-128
11 80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTEC
DIVISION OF WATER RESOURCES

Record: 2023451
PERMIT NO. ______
APPLICATION NO. ______
COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. NE 11 SURFACE ELEVATION ______ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/5/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet; Bottom ---23--- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY No Gallons per minute at --- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/7/83 Yield three Gallons per minute

Static water level before pumping ---ten ---- Feet below surface

Pumping level 12.5 feet below surface after 1.5 hours pumping

Drawdown 2.5 Feet Specific Capacity one Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at 2.5

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-Metro Corp.

Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

at surface ~~Depth of Pump in well~~ ______ Feet Depth of Footpiece in well --- Feet

~~Depth of Air Line in well~~ ______ Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT { Average three Gallons Daily; Maximum ten Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste ______ Odor ______ Color ______ Temp. ______ °F.

12. LOG see over please Are samples available? ______
(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1055

Form DWR-133

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

Record: 0022451

PERMIT NO ________

APPLICATION NO ________

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. NE 12 SURFACE ELEVATION ________ (Approx.) ________ sea level Feet

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Tw

3. DATE COMPLETED 10/5/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet, Bottom ---23--- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY No Gallons per minute at --- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/7/83 Yield three Gallons per minute

Static water level before pumping ---ten ---- Feet below surface

Pumping level 12.5 feet below surface after 1.5 hours pumping

Drawdown 2.5 Feet Specific Capacity one Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at 2.5

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-Metro Corp.

Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

at surface Depth of Pump in well ________ Feet Depth of Footpiece in well --- Feet

Depth of Air Line in well ________ Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT { Average three Gallons Daily, Maximum ten Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste ________ Odor ________ Color ________ Temp. ____ °F.

12. LOG see over please ________ Are samples available? ________

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

NLI 002 1056

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

Form DWR-138
11/80

Record: [illegible]

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTEC
DIVISION OF WATER RESOURCES

PERMIT NO [illegible]

APPLICATION NO

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. NE 13 SURFACE ELEVATION ________ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/5/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth: Top twenty Feet; Bottom ---23--- Feet

Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY No Gallons per minute at --- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/7/83 Yield three Gallons per minute

Static water level before pumping ---ten ---- Feet below surface

Pumping level 12.5 feet below surface after 1.5 hours pumping

Drawdown 2.5 Feet Specific Capacity one Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at 2.5

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-Metro Corp.

Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

at surface

Depth of Pump in well ________ Feet Depth of Footpiece in well --- Feet

Depth of Air Line in well ________ Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT: Average three Gallons Daily; Maximum ten Gallons Daily

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste ________ Odor ________ Color ________ Temp. ________ °F.

12. LOG see over please Are samples available? ________

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1057

Form DWR-138
60

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTEC
DIVISION OF WATER RESOURCES

Rcrd: 2023451
PERMIT NO ______
APPLICATION NO ______
COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.
Owner's Well No. NE 14 SURFACE ELEVATION ______ Feet (Above mean sea level)
2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.
3. DATE COMPLETED 10/5/83 DRILLER Moretrench American Corp.
4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet
5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet
6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet
Range in Depth { Top twenty Feet; Bottom ---23--- Feet } Geologic Formation Cape May Formation
Tail Piece: Diameter --- Inches Length --- Feet
7. WELL FLOWS NATURALLY No Gallons per minute at --- Feet above surface
Water rises to ----- Feet above surface
8. RECORD OF TEST: Date 10/7/83 Yield three Gallons per minute
Static water level before pumping ---ten ---- Feet below surface
Pumping level 12.5 feet below surface after 1.5 hours pumping
Drawdown 2.5 Feet Specific Capacity one Gals. per min. per ft. of drawdown
How pumped centrifugal test pump How measured five gallon pail
Observed effect on nearby wells drawdown at 2.5
9. PERMANENT PUMPING EQUIPMENT:
Type centrifugal pump Mfrs. Name Fybroc Division-Metro Corp.
Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750
at surface
Depth of Pump in well ______ Feet Depth of Footpiece in well --- Feet
Depth of Air Line in well ______ Feet Type of Meter on Pump micrometer Size six Inches
10. USED FOR ground water abatement AMOUNT { Average three Gallons Daily; Maximum ten Gallons Daily }
11. QUALITY OF WATER not tested Sample: Yes ____ No ____
Taste ______ Odor ______ Color ______ Temp. ______ °F
12. LOG see over please Are samples available? ______
(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)
13. SOURCE OF DATA ---
14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1058

Form DWR-138
11 80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTE
DIVISION OF WATER RESOURCES

PERMIT NO ______

APPLICATION NO ______

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. NE 15 SURFACE ELEVATION ______ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/5/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet / Bottom ---23--- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY No Gallons per minute at --- Feet above surface

Water rises to ------ Feet above surface

8. RECORD OF TEST: Date 10/7/83 Yield three Gallons per minute

Static water level before pumping ---ten ---- Feet below surface

Pumping level 12.5 feet below surface after 1.5 hours pumping

Drawdown 2.5 Feet Specific Capacity one Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at 2.5

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-Metro Corp.

Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

at surface Depth of Pump in well ______ Feet Depth of Footpiece in well --- Feet

Depth of Air Line in well ______ Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT { Average three Gallons Daily / Maximum ten Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ______ No ______

Taste ______ Odor ______ Color ______ Temp. ______ °F.

12. LOG see over please Are samples available? ______
(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1059

Form DWR-138
11/80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

PERMIT NO. [illegible]

APPLICATION NO.

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. NW 1 SURFACE ELEVATION ______ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/4/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening 16 slot Diameter two Inches Length three Feet

Range in Depth: Top twenty Feet; Bottom -23- Feet

Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length ---- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at ---- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/6/83 Yield fifteen Gallons per minute

Static water level before pumping ---six--- Feet below surface

Pumping level nine feet below surface after ---two--- hours pumping

Drawdown three Feet Specific Capacity five Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at three feet

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-Metro Corporation

Capacity --400-- G.P.M. How Driven electric motor H.P. -20- R.P.M. 1750

Depth of Pump in well ______ Feet Depth of Footpiece in well ---- Feet

at Surface

Depth of Air Line in well ______ Feet Type of Meter on Pump Micrometer Size six Inches

10. USED FOR Ground Water Abatement AMOUNT: Average seven Gallons Daily; Maximum fifteen Gallons Daily

11. QUALITY OF WATER Not tested Sample: Yes ____ No ____

Taste ______ Odor ______ Color ______ Temp. ______ °F.

12. LOG 0-3' Fill -- 3-23' Fine/Medium Sand. Are samples available? --

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA --

14. DATA OBTAINED BY -- Date --

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1060

Form DWR-138
11 80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

PERMIT NO. ________
APPLICATION NO. ________
COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. NW 2 SURFACE ELEVATION ________ Feet (Above mean sea level)

2. LOCATION Lot: 2- B Blk: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/4/83 DRILLER A. Jetrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening 16 slot Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet; Bottom -23- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length ---- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at ---- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/6/83 Yield fifteen Gallons per minute

Static water level before pumping ---six--- Feet below surface

Pumping level nine feet below surface after ---two--- hours pumping

Drawdown three Feet Specific Capacity five Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at three feet

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-Metro Corporation

Capacity --400-- G.P.M. How Driven electric motor H.P. -20- R.P.M. 1750

at surface

Depth of Pump in well ________ Feet Depth of Footpiece in well ---- Feet

Depth of Air Line in well ________ Feet Type of Meter on Pump Micrometer Size six Inches

10. USED FOR Ground Water Abatement AMOUNT { Average seven Gallons Daily; Maximum fifteen Gallons Daily }

11. QUALITY OF WATER Not tested Sample: Yes ____ No ____

Taste ________ Odor ________ Color ________ Temp. ____ °F.

12. LOG 0-3' Fill -- 3-23' Fine/Medium Sand. Are samples available? --

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA --

14. DATA OBTAINED BY -- Date --

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1061

Form DWR-138
1-80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

PERMIT NO. [illegible]

APPLICATION NO. ______

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. NW 3 SURFACE ELEVATION ______ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/4/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening 16 slot Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet, Bottom -23- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter --- inches Length ---- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at ---- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/6/83 Yield fifteen Gallons per minute

Static water level before pumping ---six--- Feet below surface

Pumping level nine feet below surface after ---two--- hours pumping

Drawdown three Feet Specific Capacity five Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at three feet

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-Metro Corporation

Capacity --400-- G.P.M. How Driven electric motor H.P. -20- R.P.M. 1750

Depth of Pump in well ______ Feet Depth of Footpiece in well ---- Feet

Depth of Air Line in well ______ Feet Type of Meter on Pump Micrometer Size six inches

10. USED FOR Ground Water Abatement AMOUNT { Average seven Gallons Daily, Maximum fifteen Gallons Daily }

11. QUALITY OF WATER Not tested Sample: Yes ____ No ____

Taste ______ Odor ______ Color ______ Temp. ______ °F.

12. LOG 0-3' Fill -- 3-23' Fine/Medium Sand. Are samples available? --

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA --

14. DATA OBTAINED BY -- Date --

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1062

Form DWP-138
11/80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTEC
DIVISION OF WATER RESOURCES

PERMIT NO. [illegible]

APPLICATION NO. ______

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. NW 4 SURFACE ELEVATION ______ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/4/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening 16 slot Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet / Bottom -23- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length ---- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at ---- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/6/83 Yield fifteen Gallons per minute

Static water level before pumping ---six--- Feet below surface

Pumping level nine feet below surface after ---two--- hours pumping

Drawdown three Feet Specific Capacity five Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at three feet

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-Metro Corporation

Capacity --400-- G.P.M. How Driven electric motor H.P. -20- R.P.M. 1750

at surface Depth of Pump in well ______ Feet Depth of Footpiece in well ---- Feet

Depth of Air Line in well ______ Feet Type of Meter on Pump Micrometer Size six Inches

10. USED FOR Ground Water Abatement AMOUNT { Average seven Gallons Daily / Maximum fifteen Gallons Daily }

11. QUALITY OF WATER Not tested Sample: Yes ____ No ____

Taste ______ Odor ______ Color ______ Temp. ______ °F.

12. LOG 0-3' Fill -- 3-23' Fine/Medium Sand. Are samples available? --

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA --

14. DATA OBTAINED BY -- Date --

NLI 002 1063

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

DWR-133

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECT
DIVISION OF WATER RESOURCES

PERMIT NO ______

APPLICATION NO ______

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. NW 5 SURFACE ELEVATION ______ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/4/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening 16 slot Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet; Bottom -23- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length ---- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at ---- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/6/83 Yield fifteen Gallons per minute

Static water level before pumping ---six--- Feet below surface

Pumping level nine feet below surface after ---two--- hours pumping

Drawdown three Feet Specific Capacity five Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at three feet

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-Metro Corporation

Capacity --400-- G.P.M. How Driven electric motor H.P. -20- R.P.M. 1750

Depth of Pump in well ______ Feet Depth of Footpiece in well ---- Feet

urface Depth of Air Line in well ______ Feet Type of Meter on Pump Micrometer Size six Inches

10. USED FOR Ground Water Abatement AMOUNT { Average seven Gallons Daily; Maximum fifteen Gallons Daily }

11. QUALITY OF WATER Not tested Sample: Yes ___ No ___

Taste ______ Odor ______ Color ______ Temp. ______ °F.

12. LOG 0-3' Fill -- 3-23' Fine/Medium Sand. Are samples available? --

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA --

14. DATA OBTAINED BY -- Date --

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1064

Form DWR-133

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

Record: 0023451
PERMIT NO [illegible]
APPLICATION NO
COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.
   Owner's Well No. NW 6 SURFACE ELEVATION ______ Feet (Above mean sea level)
2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.
3. DATE COMPLETED 10/4/83 DRILLER Moretrench American Corp.
4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet
5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet
6. SCREEN: Type PVC Size of Opening 16 slot Diameter two Inches Length three Feet
   Range in Depth { Top twenty Feet; Bottom -23- Feet } Geologic Formation Cape May Formation
   Tail Piece: Diameter --- Inches Length ---- Feet
7. WELL FLOWS NATURALLY NO Gallons per minute at ---- Feet above surface
   Water rises to ----- Feet above surface
8. RECORD OF TEST: Date 10/6/83 Yield fifteen Gallons per minute
   Static water level before pumping ---six--- Feet below surface
   Pumping level nine feet below surface after ---two--- hours pumping
   Drawdown three Feet Specific Capacity five Gals. per min. per ft. of drawdown
   How pumped centrifugal test pump How measured five gallon pail
   Observed effect on nearby wells drawdown at three feet
9. PERMANENT PUMPING EQUIPMENT:
   Type centrifugal pump Mfrs. Name Fybroc Division-Metro Corporation
   Capacity --400-- G.P.M. How Driven electric motor H.P. -20- R.P.M. 1750
   at surface ~~Depth of Pump in well ______ Feet~~ Depth of Footpiece in well ---- Feet
   ~~Depth of Air Line in well ______ Feet~~ Type of Meter on Pump Micrometer Size six Inches
10. USED FOR Ground Water Abatement AMOUNT { Average seven Gallons Daily; Maximum fifteen Gallons Daily }
11. QUALITY OF WATER Not tested Sample: Yes ____ No ____
    Taste ______ Odor ______ Color ______ Temp. ______ °F.
12. LOG 0-3' Fill -- 3-23' Fine/Medium Sand. Are samples available? --
    (Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)
13. SOURCE OF DATA --
14. DATA OBTAINED BY -- Date --

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1065

Form DWR-128
11-80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

PERMIT NO. [illegible]

APPLICATION NO. ______

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. NW 7 SURFACE ELEVATION ______ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/4/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening 16 slot Diameter two Inches Length three Feet

Range in Depth: Top twenty Feet; Bottom -23- Feet

Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length ---- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at ---- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/6/83 Yield fifteen Gallons per minute

Static water level before pumping ---six--- Feet below surface

Pumping level nine feet below surface after ---two--- hours pumping

Drawdown three Feet Specific Capacity five Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at three feet

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-Metro Corporation

Capacity --400-- G.P.M. How Driven electric motor H.P. -20- R.P.M. 1750

at surface ~~Depth of Pump in well ______ Feet~~ Depth of Footpiece in well ---- Feet

~~Depth of Air Line in well ______ Feet~~ Type of Meter on Pump Micrometer Size six Inches

10. USED FOR Ground Water Abatement AMOUNT: Average seven Gallons Daily; Maximum fifteen Gallons Daily

11. QUALITY OF WATER Not tested Sample: Yes ___ No ___

Taste ______ Odor ______ Color ______ Temp. ______ °F.

12. LOG 0-3' Fill -- 3-23' Fine/Medium Sand. Are samples available? --

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA --

14. DATA OBTAINED BY -- Date --

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1066

DWR-128
80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECT
DIVISION OF WATER RESOURCES

PERMIT NO

APPLICATION NO

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. NW 8 SURFACE ELEVATION ______ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/4/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening 16 slot Diameter two Inches Length three Feet

Range in Depth: Top twenty Feet; Bottom -23- Feet Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length ---- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at ---- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/6/83 Yield fifteen Gallons per minute

Static water level before pumping ---six--- Feet below surface

Pumping level nine feet below surface after ---two--- hours pumping

Drawdown three Feet Specific Capacity five Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at three feet

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-Metro Corporation

Capacity --400-- G.P.M. How Driven electric motor H.P. -20- R.P.M. 1750

Depth of Pump in well ______ Feet Depth of Footpiece in well ---- Feet

t
urface Depth of Air Line in well ______ Feet Type of Meter on Pump Micrometer Size six Inches

10. USED FOR Ground Water Abatement AMOUNT: Average seven Gallons Daily; Maximum fifteen Gallons Daily

11. QUALITY OF WATER Not tested Sample: Yes ____ No ____

Taste ______ Odor ______ Color ______ Temp. ______ °F.

12. LOG 0-3' Fill -- 3-23' Fine/Medium Sand. Are samples available? --

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA --

14. DATA OBTAINED BY -- Date --

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1067

Form DWR-138
11/80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTE
DIVISION OF WATER RESOURCES

PERMIT NO. [illegible]

APPLICATION NO. ____

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SE 1 SURFACE ELEVATION ____ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/7/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet; Bottom --23-- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter ____ Inches Length -- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at -- Feet above surface

Water rises to ---- Feet above surface

8. RECORD OF TEST: Date 10/9/83 Yield four Gallons per minute

Static water level before pumping ten Feet below surface

Pumping level thirteen feet below surface after one hours pumping

Drawdown three Feet Specific Capacity 1.33 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at three feet.

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-MetPro Corp.

Capacity 400 G.P.M. How Driven electric motor H.P. twenty R. ____

Depth of Pump in well ____ Feet Depth of Footpiece in well -- Feet

at surface Depth of Air Line in well ____ Feet Type of Meter on Pump micrometer Size 6-- Inches

10. USED FOR ground water abatement AMOUNT { Average four Gallons Daily; Maximum eight Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste -- Odor -- Color --- Temp. ____ °F.

12. LOG see over please Are samples available? ____

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA --

14. DATA OBTAINED BY -- Date --

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1068

Form DWR-128
11/80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTEC
DIVISION OF WATER RESOURCES

PERMIT NO [illegible]

APPLICATION NO ______

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SE 2 SURFACE ELEVATION ______ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/7/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet; Bottom --23-- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter ______ Inches Length -- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at -- Feet above surface

Water rises to ---- Feet above surface

8. RECORD OF TEST: Date 10/9/83 Yield four Gallons per minute

Static water level before pumping ten Feet below surface

Pumping level thirteen feet below surface after one hours pumping

Drawdown three Feet Specific Capacity 1.33 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at three feet.

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-MetPro Corp.

Capacity 400 G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

~~Depth of Pump in well ______ Feet~~ Depth of Footpiece in well -- Feet

at surface ~~Depth of Air Line in well ______ Feet~~ Type of Meter on Pump micrometer Size 6 -- Inches

10. USED FOR ground water abatement AMOUNT { Average four Gallons Daily; Maximum eight Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste -- Odor -- Color --- Temp. ____ °F.

12. LOG see over please Are samples available? ______

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA --

14. DATA OBTAINED BY -- Date --

NLI 002 1069

***(NOTE:** Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)*

Form DWR-138
11/80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

PERMIT NO 30-3155

APPLICATION NO

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SE3 SURFACE ELEVATION ____ Feet (Above mean sea level)

2. LOCATION Lot: 3-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/7/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet; Bottom --23-- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter ____ Inches Length -- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at -- Feet above surface

Water rises to ---- Feet above surface

8. RECORD OF TEST: Date 10/9/83 Yield four Gallons per minute

Static water level before pumping ten Feet below surface

Pumping level thirteen feet below surface after one hours pumping

Drawdown three Feet Specific Capacity 1.33 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at three feet.

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-MetPro Corp.

Capacity 400 G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

~~Depth of Pump in well ____ Feet~~ Depth of Footpiece in well -- Feet

at surface ~~Depth of Air Line in well ____ Feet~~ Type of Meter on Pump micrometer Size 6 -- Inches

10. USED FOR ground water abatement AMOUNT { Average four Gallons Daily; Maximum eight Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste -- Odor -- Color --- Temp. ____ °F.

12. LOG see over please Are samples available? ____

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA --

14. DATA OBTAINED BY -- Date --

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1070

Form DWR-138
11/80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTEC
DIVISION OF WATER RESOURCES

PERMIT NO [illegible]

APPLICATION NO ______

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.
   Owner's Well No. NE 1 SURFACE ELEVATION ______ Feet (Above mean sea level)
2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.
3. DATE COMPLETED 10/7/83 DRILLER Moretrench American Corp.
4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet
5. CASING: Type PVC Diameter 1-1/2 inches Length twenty Feet
6. SCREEN: Type PVC Size of Opening .016 Diameter two inches Length three Feet
   Range in Depth { Top twenty Feet / Bottom --23-- Feet } Geologic Formation Cape May Formation
   Tail Piece: Diameter ______ Inches Length -- Feet
7. WELL FLOWS NATURALLY NO Gallons per minute at -- Feet above surface
   Water rises to ---- Feet above surface
8. RECORD OF TEST: Date 10/9/83 Yield four Gallons per minute
   Static water level before pumping ten Feet below surface
   Pumping level thirteen feet below surface after one hours pumping
   Drawdown three Feet Specific Capacity 1.33 Gals. per min. per ft. of drawdown
   How pumped centrifugal test pump How measured five gallon pail
   Observed effect on nearby wells drawdown at three feet.
9. PERMANENT PUMPING EQUIPMENT:
   Type centrifugal pump Mfrs. Name Fybroc Division-MetPro Corp.
   Capacity 400 G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750
   Depth of Pump in well ______ Feet Depth of Footpiece in well -- Feet
   at surface Depth of Air Line in well ______ Feet Type of Meter on Pump micrometer Size 6-- Inches
10. USED FOR ground water abatement AMOUNT { Average four Gallons Daily / Maximum eight Gallons Daily }
11. QUALITY OF WATER not tested Sample: Yes ____ No ____
    Taste -- Odor -- Color --- Temp. ____ °F.
12. LOG see over please Are samples available? ______
    (Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)
13. SOURCE OF DATA --
14. DATA OBTAINED BY -- Date --

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1071

Form DWR-128
1/80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

PERMIT NO. 33-3168

APPLICATION NO.

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SE 4 SURFACE ELEVATION ________ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/6/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet; Bottom --23-- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at --- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/8/83 Yield ten Gallons per minute

Static water level before pumping ----ten---- Feet below surface

Pumping level fourteen feet below surface after 2.5 hours pumping

Drawdown four Feet Specific Capacity 2.5 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at four feet

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division - Metro Corp.

Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

Depth of Pump in well ________ Feet Depth of Footpiece in well --- Feet

at surface

Depth of Air Line in well ________ Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT { Average ten Gallons Daily; Maximum fifteen Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste -- Odor -- Color --- Temp. ____ °F.

12. LOG see over please Are samples available? ________

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 02 1072

Form DWR-133
1-80

[illegible]

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

PERMIT NO. [illegible]

APPLICATION NO. [illegible]

COUNTY

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SE 5 SURFACE ELEVATION ______ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans

3. DATE COMPLETED 10/6/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet; Bottom --23-- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at --- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/8/83 Yield ten Gallons per minute

Static water level before pumping ----ten---- Feet below surface

Pumping level fourteen feet below surface after 2.5 hours pumping

Drawdown four Feet Specific Capacity 2.5 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at four feet

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division - Metro Corp.

Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

at surface

~~Depth of Pump in well~~ ______ Feet Depth of Footpiece in well --- Feet

~~Depth of Air Line in well~~ ______ Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT { Average ten Gallons Daily; Maximum fifteen Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste -- Odor -- Color --- Temp. ____ °F.

12. LOG see over please Are samples available? ______

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 02 1073

· 50

DEPARTMENT OF ENVIRONMENTAL ...
DIVISION OF WATER RESOURCES

APPLICATION NO. ______
COUNTY ______

WELL RECORD

OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SE 6 SURFACE ELEVATION ______ Feet (above mean sea level)

1. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

2. DATE COMPLETED 10/6/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two inches Length three Feet

Range in Depth { Top twenty Feet; Bottom -23-- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter --- inches Length --- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at --- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/8/83 Yield ten Gallons per minute

Static water level before pumping ----ten---- Feet below surface

Pumping level fourteen feet below surface after 2.5 hours pumping

Drawdown four Feet Specific Capacity 2.5 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at four feet

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division - Metro Corp

Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

at surface ~~Depth of Pump in well~~ ______ Feet Depth of Footpiece in well --- Feet

~~Depth of Air Line in well~~ ______ Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT { Average ten Gallons Daily; Maximum fifteen Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste -- Odor -- Color --- Temp. ____ °F.

12. LOG see over please Are samples available? ______

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1074

Form DWR-138
11/80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

PERMIT NO. [illegible]

APPLICATION NO. ______

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SE 7 SURFACE ELEVATION ______ (Above mean sea level) ______ Feet

2. LOCATION Lot: 2-17 Block: 37 Municipality: [illegible] Mans [illegible]

3. DATE COMPLETED 10/6/83 DRILLER Moretre [illegible] [illegible]ican Co.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-[illegible] Feet

5. CASING: Type PVC Diameter 1-1/2 inches Length [illegible]nty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length [illegible]ree Feet

Range in Depth { Top twenty Feet / Bottom --23-- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at --- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/8/83 Yield ten Gallons per minute

Static water level before pumping ----ten---- Feet below surface

Pumping level fourteen feet below surface after 2.5 hours pumping

Drawdown four Feet Specific Capacity 2.5 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at four feet

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division - Metro Corp.

Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

at surface

Depth of Pump in well ______ Feet Depth of Footpiece in well --- Feet

Depth of Air Line in well ______ Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT { Average ten Gallons Daily / Maximum fifteen Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste -- Odor -- Color --- Temp. ____ °F.

12. LOG see over please ______ Are samples available? ______
(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1075

Form DWR-[illegible]
[illegible] 80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

PERMIT NO [illegible]

APPLICATION NO. [illegible]

COUNTY

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SE 8 SURFACE ELEVATION ______ Feet (above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/6/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet; Bottom -23-- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at --- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/8/83 Yield ten Gallons per minute

Static water level before pumping ----ten---- Feet below surface

Pumping level fourteen feet below surface after 2.5 hours pumping

Drawdown four Feet Specific Capacity 2.5 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at four feet

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division - Metro Corp.

Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

at surface

Depth of Pump in well ______ Feet Depth of Footpiece in well --- Feet

Depth of Air Line in well ______ Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT { Average ten Gallons Daily; Maximum fifteen Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste -- Odor -- Color --- Temp. ____ °F.

12. LOG see over please Are samples available? ______

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1076

Form DWR-138
11/80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

PERMIT NO [illegible]

APPLICATION NO

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SE 9 SURFACE ELEVATION ____ Feet (Above mean sea level)

2. LOCATION Lot: 7 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/6/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth: Top twenty Feet; Bottom --23-- Feet

Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at --- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/8/83 Yield ten Gallons per minute

Static water level before pumping ----ten---- Feet below surface

Pumping level fourteen feet below surface after 2.5 hours pumping

Drawdown four Feet Specific Capacity 2.5 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at four feet

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division - Metro Corp.

Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

at surface

Depth of Pump in well ____ Feet Depth of Footpiece in well --- Feet

Depth of Air Line in well ____ Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT: Average ten Gallons Daily; Maximum fifteen Gallons Daily

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste -- Odor -- Color --- Temp. ____ °F.

12. LOG see over please Are samples available? ____

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1077

Form DWR-138
11/80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

PERMIT NO. ______

APPLICATION NO. ______

COUNTY ______

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SE 10 SURFACE ELEVATION ______ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/6/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet; Bottom --23-- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at --- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/8/83 Yield ten Gallons per minute

Static water level before pumping ----ten---- Feet below surface

Pumping level fourteen feet below surface after 2.5 hours pumping

Drawdown four Feet Specific Capacity 2.5 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at four feet

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division - Metro Corp.

Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

at surface

~~Depth of Pump in well~~ ______ Feet Depth of Footpiece in well --- Feet

~~Depth of Air Line in well~~ ______ Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT { Average ten Gallons Daily; Maximum fifteen Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste -- Odor -- Color --- Temp. ____ °F.

12. LOG see over please Are samples available? ______

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1078

DWR-138

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

PERMIT NO. 30-[illegible]

APPLICATION NO.

COUNTY Salem

WELL RECORD

OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SE 11 SURFACE ELEVATION ______ Feet (Above mean sea level)

1. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

2. DATE COMPLETED 10/6/83 DRILLER Moretrench American Corp.

3. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

4. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

5. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth: Top twenty Feet; Bottom --23-- Feet Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at --- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/8/83 Yield ten Gallons per minute

Static water level before pumping ----ten---- Feet below surface

Pumping level fourteen feet below surface after 2.5 hours pumping

Drawdown four Feet Specific Capacity 2.5 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at four feet

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division - Metro Corp.

Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

Depth of Pump in well ______ Feet Depth of Footpiece in well --- Feet

urface

Depth of Air Line in well ______ Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT: Average ten Gallons Daily; Maximum fifteen Gallons Daily

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste -- Odor -- Color --- Temp. ____ °F.

12. LOG see over please Are samples available? ______

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1079

Form DWR-128
1-80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECT.
DIVISION OF WATER RESOURCES

PERMIT NO [illegible]

APPLICATION NO [illegible]

COUNTY

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SE 12 SURFACE ELEVATION Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/6/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet; Bottom --23-- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at --- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/8/83 Yield ten Gallons per minute

Static water level before pumping ----ten---- Feet below surface

Pumping level fourteen feet below surface after 2.5 hours pumping

Drawdown four Feet Specific Capacity 2.5 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at four feet

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division - Metro Corp.

Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

at surface ~~Depth of Pump in well~~ Feet Depth of Footpiece in well --- Feet

~~Depth of Air Line in well~~ Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT { Average ten Gallons Daily; Maximum fifteen Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ___ No ___

Taste -- Odor -- Color --- Temp. °F.

12. LOG see over please Are samples available?
(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

NLI 002 1080

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

Form DWR-138
11/80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

PERMIT NO ____

APPLICATION NO ____

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SE 13 SURFACE ELEVATION ____ Feet (above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/6/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet / Bottom --23-- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at --- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/8/83 Yield ten Gallons per minute

Static water level before pumping ----ten---- Feet below surface

Pumping level fourteen feet below surface after 2.5 hours pumping

Drawdown four Feet Specific Capacity 2.5 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at four feet

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division - Metro Corp.

Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

at surface

Depth of Pump in well ____ Feet Depth of Footpiece in well --- Feet

Depth of Air Line in well ____ Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT { Average ten Gallons Daily / Maximum fifteen Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste -- Odor -- Color --- Temp. ____ °F.

12. LOG see over please Are samples available? ____

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1081

Form DWR-128
1/80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECT
DIVISION OF WATER RESOURCES

PERMIT NO. ______

APPLICATION NO. ______

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SE 14 SURFACE ELEVATION ______ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/6/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 Inches Bottom two Inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet / Bottom -23-- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at --- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/8/83 Yield ten Gallons per minute

Static water level before pumping ----ten---- Feet below surface

Pumping level fourteen feet below surface after 2.5 hours pumping

Drawdown four Feet Specific Capacity 2.5 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at four feet

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division - Metro Corp.

Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

at surface Depth of Pump in well ______ Feet Depth of Footpiece in well --- Feet

Depth of Air Line in well ______ Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT { Average ten Gallons Daily / Maximum fifteen Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste -- Odor -- Color --- Temp. ____ °F.

12. LOG see over please Are samples available? ______

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

NLI 002 1082

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

Form DWR-138
11/80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTEC
DIVISION OF WATER RESOURCES

PERMIT NO [illegible]

APPLICATION NO ______

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SE 15 SURFACE ELEVATION ______ Feet (Above mean sea lev)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/6/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth: Top twenty Feet; Bottom -23-- Feet

Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at --- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/8/83 Yield ten Gallons per minute

Static water level before pumping ----ten---- Feet below surface

Pumping level fourteen feet below surface after 2.5 hours pumping

Drawdown four Feet Specific Capacity 2.5 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at four feet

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division - Metro Corp.

Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

at surface

Depth of Pump in well ______ Feet Depth of Footpiece in well --- Feet

Depth of Air Line in well ______ Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT: Average ten Gallons Daily; Maximum fifteen Gallons Daily

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste -- Odor -- Color --- Temp. ____ °F.

12. LOG see over please Are samples available? ______

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

NLI 002 1083

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

· 80

DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

APPLICATION NO. ______
COUNTY ______

WELL RECORD

OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SE 16 SURFACE ELEVATION ______ Feet (above mean sea level)

1. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans

2. DATE COMPLETED 10/6/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet; Bottom --23-- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at --- Feet above surface

Water rises to ----- Feet above surface

8. RECORD OF TEST: Date 10/8/83 Yield ten Gallons per minute

Static water level before pumping ----ten---- Feet below surface

Pumping level fourteen feet below surface after 2.5 hours pumping

Drawdown four Feet Specific Capacity 2.5 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at four feet

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division - Metro Corp.

Capacity --400-- G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

at surface
Depth of Pump in well ______ Feet Depth of Footpiece in well --- Feet

Depth of Air Line in well ______ Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT { Average ten Gallons Daily; Maximum fifteen Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ______ No ______

Taste -- Odor -- Color --- Temp. ______ °F.

12. LOG see over please Are samples available? ______
(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1084

Form DWR-128
11 80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECT.
DIVISION OF WATER RESOURCES

PERMIT NO 30-3131

APPLICATION NO

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. NE 4 SURFACE ELEVATION ______ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/7/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth: Top twenty Feet; Bottom --23-- Feet

Geologic Formation Cape May Formation

Tail Piece: Diameter ______ Inches Length -- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at -- Feet above surface

Water rises to ---- Feet above surface

8. RECORD OF TEST: Date 10/9/83 Yield four Gallons per minute

Static water level before pumping ten Feet below surface

Pumping level thirteen feet below surface after one hours pumping

Drawdown three Feet Specific Capacity 1.33 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at three feet.

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-MetPro Corp.

Capacity 400 G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

~~Depth of Pump in well ______ Feet~~ Depth of Footpiece in well -- Feet

surface ~~Depth of Air Line in well ______ Feet~~ Type of Meter on Pump micrometer Size 6-- Inches

10. USED FOR ground water abatement AMOUNT: Average four Gallons Daily; Maximum eight Gallons Daily

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste -- Odor -- Color --- Temp. ____ °F.

12. LOG see over please Are samples available? ______

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA --

14. DATA OBTAINED BY -- Date --

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1085

DEPARTMENT OF ENVIRONMENTAL PROTE[CTION]
DIVISION OF WATER RESOURCES

PERMIT NO. [illegible]

APPLICATION NO. ______

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SW 0 SURFACE ELEVATION ______ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/7/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH Twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet, Bottom --23-- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter ______ Inches Length -- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at -- Feet above surface

Water rises to ---- Feet above surface

8. RECORD OF TEST: Date 10/9/83 Yield four Gallons per minute

Static water level before pumping ten Feet below surface

Pumping level thirteen feet below surface after one hours pumping

Drawdown three Feet Specific Capacity 1.33 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at three feet.

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-MetPro Corp.

Capacity 400 G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

~~Depth of Pump in well ______ Feet~~ Depth of Footpiece in well -- Feet

at surface ~~Depth of Air Line in well ______ Feet~~ Type of Meter on Pump micrometer Size 6-- Inches

10. USED FOR ground water abatement AMOUNT { Average four Gallons Daily, Maximum eight Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste -- Odor -- Color --- Temp. ____ °F.

12. LOG see over please Are samples available? ______
(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA --

14. DATA OBTAINED BY -- Date --

NLI 002 1086

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

Form DWR-138
11/80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

PERMIT NO. 30-3139

APPLICATION NO. ______

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SW 1 SURFACE ELEVATION ______ Feet (above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldman Twp.

3. DATE COMPLETED 10/7/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth: Top twenty Feet; Bottom --23-- Feet

Geologic Formation Cape May Formation

Tail Piece: Diameter ______ Inches Length -- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at -- Feet above surface

Water rises to ---- Feet above surface

8. RECORD OF TEST: Date 10/9/83 Yield four Gallons per minute

Static water level before pumping ten Feet below surface

Pumping level thirteen feet below surface after one hours pumping

Drawdown three Feet Specific Capacity 1.33 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at three feet.

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-MetPro Corp.

Capacity 400 G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

Depth of Pump in well ~~______~~ Feet Depth of Footpiece in well -- Feet

at surface Depth of Air Line in well ~~______~~ Feet Type of Meter on Pump micrometer Size 6 -- Inches

10. USED FOR ground water abatement AMOUNT: Average four Gallons Daily; Maximum eight Gallons Daily

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste -- Odor -- Color --- Temp. ______ °F.

12. LOG see over please Are samples available? ______

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA --

14. DATA OBTAINED BY -- Date --

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1087

Form DWR-138
11 80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTEC
DIVISION OF WATER RESOURCES

PERMIT NO. ____

APPLICATION NO ____

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SW2 SURFACE ELEVATION ____ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/7/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two Inches Length three Feet

Range in Depth: Top twenty Feet; Bottom --23-- Feet   Geologic Formation Cape May Formation

Tail Piece: Diameter ____ Inches Length -- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at -- Feet above surface

Water rises to ---- Feet above surface

8. RECORD OF TEST: Date 10/9/83 Yield four Gallons per minute

Static water level before pumping ten Feet below surface

Pumping level thirteen feet below surface after one hours pumping

Drawdown three Feet Specific Capacity 1.33 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump ____ How measured five gallon pail

Observed effect on nearby wells drawdown at three feet.

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-MetPro Corp.

Capacity 400 G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

Depth of Pump in well ____ Feet Depth of Footpiece in well -- Feet

at surface Depth of Air Line in well ____ Feet Type of Meter on Pump micrometer Size 6 -- Inches

10. USED FOR ground water abatement AMOUNT: Average four Gallons Daily; Maximum eight Gallons Daily

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste -- Odor -- Color --- Temp. ____ °F.

12. LOG see over please Are samples available? ____

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA --

14. DATA OBTAINED BY -- Date --

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1088

Form DWR-138
1/80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

[illegible]
PERMIT NO [illegible]
APPLICATION NO ______
COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SW3 SURFACE ELEVATION ______ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/7/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Fe

5. CASING: Type PVC Diameter 1-1/2 inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening .016 Diameter two inches Length three Fe

Range in Depth { Top twenty Feet / Bottom --23-- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter ______ inches Length -- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at -- Feet above surface

Water rises to ---- Feet above surface

8. RECORD OF TEST: Date 10/9/83 Yield four Gallons per minute

Static water level before pumping ten Feet below surface

Pumping level thirteen feet below surface after one hours pumping

Drawdown three Feet Specific Capacity 1.33 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at three feet.

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division-MetPro Corp.

Capacity 400 G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

Depth of Pump in well ______ Feet Depth of Footpiece in well -- Feet

at surface Depth of Air-Line in well ______ Feet Type of Meter on Pump micrometer Size 6-- Inches

10. USED FOR ground water abatement AMOUNT { Average four Gallons Daily / Maximum eight Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste -- Odor -- Color --- Temp. ____ °F.

12. LOG see over please Are samples available? ______

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA --

14. DATA OBTAINED BY -- Date --

NLI 002 1089

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

Form DWR-138
11 80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTEC
DIVISION OF WATER RESOURCES

PERMIT NO 30-3191

APPLICATION NO

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SW4 SURFACE ELEVATION ______ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/10/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening ______ Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet; Bottom --23-- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at -- Feet above surface

Water rises to --- Feet above surface

8. RECORD OF TEST: Date 10/12/83 Yield five Gallons per minute

Static water level before pumping eighteen Feet below surface

Pumping level nineteen feet below surface after 2.5 hours pumping

Drawdown one Feet Specific Capacity 2.5 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at one foot

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division, Metro Corp.

Capacity 400 G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

Depth of Pump in well ______ Feet Depth of Footpiece in well ______ Feet

Depth of Air Line in well ______ Feet Type of Meter on Pump Micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT { Average five Gallons Daily; Maximum seven Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste ______ Odor ______ Color ______ Temp. ______ °F.

12. LOG see over please. Are samples available? ______

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1090

Form DWR-138
11/80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTEC
DIVISION OF WATER RESOURCES

PERMIT NO 30-3193

APPLICATION NO

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SW 5 SURFACE ELEVATION Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/10/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet; Bottom --23-- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at -- Feet above surface

Water rises to --- Feet above surface

8. RECORD OF TEST: Date 10/12/83 Yield five Gallons per minute

Static water level before pumping eighteen Feet below surface

Pumping level nineteen feet below surface after 2.5 hours pumping

Drawdown one Feet Specific Capacity 2.5 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at one foot

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division, Metro Corp.

Capacity 400 G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

er.
face

~~Depth of Pump in well Feet~~ Depth of Footpiece in well Feet

~~Depth of Air Line in well Feet~~ Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT { Average five Gallons Daily; Maximum seven Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes No

Taste Odor Color Temp. °F.

12. LOG see over please. Are samples available?
(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1091

Form DWR-138
11.80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTEC
DIVISION OF WATER RESOURCES

[illegible]

PERMIT NO [illegible]-3194

APPLICATION NO ______

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SW 6 SURFACE ELEVATION ______ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/10/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening ______ Diameter two inches Length three Feet

Range in Depth { Top twenty Feet / Bottom --23-- Feet }   Geologic Formation Cape May Formation

Tail Piece: Diameter --- inches Length --- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at -- Feet above surface

Water rises to --- Feet above surface

8. RECORD OF TEST: Date 10/12/83 Yield five Gallons per minute

Static water level before pumping eighteen Feet below surface

Pumping level nineteen feet below surface after 2.5 hours pumping

Drawdown one Feet Specific Capacity 2.5 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at one foot

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division, Metro Corp.

Capacity 400 G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

at gr. surface

Depth of Pump in well ______ Feet Depth of Footpiece in well ______ Feet

Depth of Air Line in well ______ Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT { Average five Gallons Daily / Maximum seven Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste ______ Odor ______ Color ______ Temp. ______ °F.

12. LOG see over please. Are samples available? ______

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

NLI 002 1092

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

Form DWR-138
11/80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

PERMIT NO. 30-3195

APPLICATION NO. ______

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SW 7 SURFACE ELEVATION ______ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 B Bk: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/10/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening ______ Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet; Bottom --23 Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at -- Feet above surface

Water rises to --- Feet above surface

8. RECORD OF TEST: Date 10/12/83 Yield five Gallons per minute

Static water level before pumping eighteen Feet below surface

Pumping level nineteen feet below surface after 2.5 hours pumping

Drawdown one Feet Specific Capacity 2.5 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at one foot

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division, Metro Corp.

Capacity 400 G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

1 gr. face

~~Depth of Pump in well ______ Feet~~ Depth of Footpiece in well ______ Feet

~~Depth of Air Line in well ______ Feet~~ Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT { Average five Gallons Daily; Maximum seven Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste ______ Odor ______ Color ______ Temp. ______ °F.

12. LOG see over please. Are samples available? ______

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1093

11/80

DEPARTMENT OF ENVIRONMENTAL PROTE[illegible]
DIVISION OF WATER RESOURCES

PERMIT NO. [illegible]

APPLICATION NO

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SW 8 SURFACE ELEVATION ____ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans T p.

3. DATE COMPLETED 10/10/83 DRILLER Moretrench Ameri n Cor

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening ____ Diameter two Inches Length three Feet

Range in Depth: Top twenty Feet; Bottom --23-- Feet

Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at -- Feet above surface

Water rises to --- Feet above surface

8. RECORD OF TEST: Date 10/12/83 Yield five Gallons per minute

Static water level before pumping eighteen Feet below surface

Pumping level nineteen feet below surface after 2.5 hours pumping

Drawdown one Feet Specific Capacity 2.5 Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at one foot

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division, Metro Corp.

Capacity 400 G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

ft. gr. surface

Depth of Pump in well ____ Feet Depth of Footpiece in well ____ Feet

Depth of Air Line in well ____ Feet Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT: Average five Gallons Daily; Maximum seven Gallons Daily

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste ____ Odor ____ Color ____ Temp. ____ °F.

12. LOG see over please. Are samples available? ____

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA ---

14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1094

Form DWR-138
11/80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

PROTO: [illegible]
PERMIT NO [illegible]
APPLICATION NO ______
COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.
   Owner's Well No. SW 9 SURFACE ELEVATION ______ Feet (Above mean sea level)
2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.
3. DATE COMPLETED 10/10/83 DRILLER Moretrench American Corp.
4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet
5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet
6. SCREEN: Type PVC Size of Opening ______ Diameter two Inches Length three Feet
   Range in Depth: Top twenty Feet; Bottom --23-- Feet
   Geologic Formation Cape May Formation
   Tail Piece: Diameter --- Inches Length --- Feet
7. WELL FLOWS NATURALLY NO Gallons per minute at -- Feet above surface
   Water rises to --- Feet above surface
8. RECORD OF TEST: Date 10/12/83 Yield five Gallons per minute
   Static water level before pumping eighteen Feet below surface
   Pumping level nineteen feet below surface after 2.5 hours pumping
   Drawdown one Feet Specific Capacity 2.5 Gals. per min. per ft. of drawdown
   How pumped centrifugal test pump How measured five gallon pail
   Observed effect on nearby wells drawdown at one foot
9. PERMANENT PUMPING EQUIPMENT:
   Type centrifugal pump Mfrs. Name Fybroc Division, Metro Corp.
   Capacity 400 G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750
   gr. face
   ~~Depth of Pump in well ______ Feet~~ Depth of Footpiece in well ______ Feet
   ~~Depth of Air Line in well ______ Feet~~ Type of Meter on Pump micrometer Size six Inches
10. USED FOR ground water abatement AMOUNT: Average five Gallons Daily; Maximum seven Gallons Daily
11. QUALITY OF WATER not tested Sample: Yes ______ No ______
    Taste ______ Odor ______ Color ______ Temp. ______ °F.
12. LOG see over please. Are samples available? ______
    (Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)
13. SOURCE OF DATA ---
14. DATA OBTAINED BY --- Date ---

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1095

Form DWR-128

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

PERMIT NO. 30-3193

APPLICATION NO. ____

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SW 10 SURFACE ELEVATION ____ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/11/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening ____ Diameter two Inches Length three Feet

Range in Depth: Top twenty Feet; Bottom --23-- Feet

Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at ____ Feet above surface

Water rises to ____ Feet above surface

8. RECORD OF TEST: Date 10/15/83 Yield ten Gallons per minute

Static water level before pumping ten Feet below surface

Pumping level twelve feet below surface after two hours pumping

Drawdown two Feet Specific Capacity five Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at two feet

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division - Metro Corp.

Capacity four hundred G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

~~Depth of Pump in well~~ ____ Feet Depth of Footpiece in well ____ Feet

~~Depth of Air Line in well~~ ____ Feet at gr. surface Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT: Average ten Gallons Daily; Maximum fifteen Gallons Daily

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste ____ Odor ____ Color ____ Temp. ____ °F.

12. LOG see reverse side please. Are samples available? ____

(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA --

14. DATA OBTAINED BY -- Date --

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1096

Form DWR-138
11/80

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

PERMIT NO. 30-3[illegible]

APPLICATION NO. ____

COUNTY Salem

WELL RECORD

1. OWNER NATIONAL SMELTING OF NJ ADDRESS PENNSVILLE PEDRICKTOWN RD.

Owner's Well No. SW 11 SURFACE ELEVATION ____ Feet (Above mean sea level)

2. LOCATION Lot: 2-17 Block: 37 Municipality: Oldmans Twp.

3. DATE COMPLETED 10/11/83 DRILLER Moretrench American Corp.

4. DIAMETER: Top 1-1/2 inches Bottom two inches TOTAL DEPTH twenty-three Feet

5. CASING: Type PVC Diameter 1-1/2 Inches Length twenty Feet

6. SCREEN: Type PVC Size of Opening ____ Diameter two Inches Length three Feet

Range in Depth { Top twenty Feet; Bottom --23-- Feet } Geologic Formation Cape May Formation

Tail Piece: Diameter --- Inches Length --- Feet

7. WELL FLOWS NATURALLY NO Gallons per minute at ____ Feet above surface

Water rises to ____ Feet above surface

8. RECORD OF TEST: Date 10/15/83 Yield ten Gallons per minute

Static water level before pumping ten Feet below surface

Pumping level twelve feet below surface after two hours pumping

Drawdown two Feet Specific Capacity five Gals. per min. per ft. of drawdown

How pumped centrifugal test pump How measured five gallon pail

Observed effect on nearby wells drawdown at two feet

9. PERMANENT PUMPING EQUIPMENT:

Type centrifugal pump Mfrs. Name Fybroc Division - Metro Corp.

Capacity four hundred G.P.M. How Driven electric motor H.P. twenty R.P.M. 1750

~~Depth of Pump in well ____ Feet~~ Depth of Footpiece in well ____ Feet

at gr. surface ~~Depth of Air Line in well ____ Feet~~ Type of Meter on Pump micrometer Size six Inches

10. USED FOR ground water abatement AMOUNT { Average ten Gallons Daily; Maximum fifteen Gallons Daily }

11. QUALITY OF WATER not tested Sample: Yes ____ No ____

Taste ____ Odor ____ Color ____ Temp. ____ °F.

12. LOG see reverse side please. Are samples available? ____
(Give details on back of sheet or on separate sheet. If electric log was made, please furnish copy.)

13. SOURCE OF DATA --

14. DATA OBTAINED BY -- Date --

(NOTE: Use other side of this sheet for additional information such as log of materials penetrated, analysis of the water, sketch map, sketch of special casing arrangements, etc.)

NLI 002 1097

State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
. . 029
TRENTON, NEW JERSEY 08625

JOHN W. GASTON JR., P.E.
DIRECTOR

DIRK C. . . FMAN P.E.
DEPUTY DIRECTOR

FEB 22 1984

NL Industries, Inc.
Environmental Control Department
P.O. Box 1090
Hightstown, New Jersey 08520

ATTENTION: Mr. Wil am K. Weddendorf

RE: Results from s...t sampling of .round water
abatement system installed by NL
Oldmans Township, Salem County

Dear Mr. Weddendorf:

NJDEP has received the analytical results from NL's test of the recently-installed ground water abatement system at the Pedricktown : cility. Enclosed or your information are NJDEP's analytical : sults of the sample taken from the southeast quadrant of the system c.. December 1, 1983.

If you have any questions, please contact this writer at (609) 292-1924.

Very truly yours,

Joseph R. Douglass
Senior Environmental Specialist
Southern Region
Enforcement Element

E23:ral

cc: Bureau of Ground Water Discharge Permits
National Smelting of New Jersey
Oldmans Township
Salem County Health Department
Paul Kahn, ORS

NLI 002 1098

RECEIVED
FEB 27 1984
ENVIRONMENTAL
CONTROL

ST-001

STATE OF NEW JERSEY
Department of Environmental Protection
Water Analysis

USE TYPE OR PRINT
BALLPOINT PEN

-553-

DATE REC'D
BOTTLE NO.
DATE REC'D
STORET ENT / READ

COUNTY: Salem
LOCATION: Penns Grove - Pennsville Rd
SAMPLES FROM SE QUADRANT IS WELL POINT
SYSTEM PUMPED ~ 3 HRS BEFORE SAMPLING

Station Identification Number	YR. MO. DAY	HOUR	Sample No
	831201	1203	

FIELD ANALYSIS

Parameter	Code	Value
Temp. °C	(2) P00010	
D.O. Winkler	(3) P00300	
D.O. Probe	(4) P00299	
pH (Field)	(5) P00400	
Gage ht.-ft.	(6) P00003	
Flow CFS	(7) P00061	
Depth ft.	(8) P00065	
Cond. 25°C	(9) P00095	872
Salinity °/oo	(10) P00480	
Stage	(11) P70211	

CONDITION CODES

Parameter	Code	Value
Weather conditions	(12) P00041	
Severity	(13) P01351	
Severity	(14) P013__	
Severity	(15) P013__	

NUTRIENTS

LEVEL ☐ HIGH ☐ LOW

Parameter	Code	Value
NH3-N	(16) P00615	
NO2 + NO3-N	(17) P00630	
NH3-N	(18) P00610	
Kjeldahl N	(19) P00625	
P ☐	(20) P70507	
PO4 ☐	(21) P00660	
Phosphorus-P ☐	(22) P00665	
PO4 ☐	(23) P00650	

BACTERIOLOGICAL — DILUTIONS (REQUESTED)

Fecal Coliform
Total Coliform
Fecal Streptococci

Parameter	Code	Value
Fecal coli /100 ml ☐ MPN	(24) P31615	
☐ MF	(25) P31613	
☐ Fecal Strept MPN/100ml	(26) P31677	
☐ Tot coli MPN/100 ml	(27) P31505	

BIOCHEMICAL OXYGEN DEMAND

INITIAL D.O. (lab.)________ SAMPLE

SEED... YES ☐ NO ☐

CONC.%

BOD

Parameter	Code	Value
☐ BOD 5-DAY	(28) P310	
6-DAY	(29) P312	
☐ COD	(30) P340	
☐ TOC	(31) P00680	
☐ Color Pt - Cou	(32) P00080	
☑ Turbidity	(33) P00076	0.9
☐ Suspended Solids	(34) P00530	
☐ Suspended Solids Ash	(35) P00540	
☐ Tot. Solids	(36) P00500	
☐ Tot. Solids - Ash	(37) P00510	
☑ Tot. Dissolved Solids (TDS)	(38) P70300	6524

Laboratory

Parameter	Code	Value
☐ pH (LAB)	(39) P00403	
☐ Alkalinity as $CaCO_3$	(40) P00410	
☐ Min. Acidity as $CaCO_3$	(41) P00436	
☐ Chloride	(42) P00940	
☐ MBAS	(43) P38260	
☐ Phenols	(44) P32730	
☐ Hardness - tot. as $CaCO_3$	(45) P00900	
☑ Sulfate	(46) P00945	4536
☐ Oil & Grease	(47) P00556	
☐ Petroleum Hydrocarbons	(48) P45501	
☐ Cyanide	(49) P00720	
☑ As - tot ug/l	(50) P01002	112
☑ Cd - tot ug/l	(51) P01027	104
☐ Cr - tot ug/l	(52) P01034	
☐ Cu - tot ug/l	(53) P01042	
☐ Fe - tot ug/l	(54) P01045	
☑ Hg - tot ug/l	(55) P71900	0.54
☐ Mn - tot ug/l	(56) P01055	
☑ Ni - tot ug/l	(57) P01067	205
☑ Pb - tot ug/l	(58) P01051	100
☑ Zn - tot ug/l	(59) P01092	3450

ADDITIONAL ANALYSIS

☐ ________	P________	
☐ ________	P________	
☐ ________	P________	
☐ ________	P________	
☐ ________	P________	

NLI 002 1099

RESULTS mg/l unless otherwise noted

Chemist Review ____________________

Part 1 (White) - Water Quality Inventory Copy
Part 2 (Canary) - Laboratory Copy
Part 3 (Pink) - Laboratory Copy
Part 4 (Goldenrod) - Field Samplers Copy

STATE OF NEW JERSEY
Department of Environmental Protection
Water Analysis

4566

USE TYPE OR PRINT BALLPOINT PEN

County: Salem
Location: ... - ... Corp
Remarks: Same as 4565 only field filtered

Station Identification Number	YR MO. DAY	HOUR	Sample No
	831201	1203	

FIELD ANALYSIS

Water Temp. °C (2) P00010; D.O. - Winkler (3) P00300; D.O. - Probe (4) P00299; pH (Field) (5) P00400; Sample Depth-ft. (6) P00003; Stream Flow-CFS (7) P00061; Gage Height-ft. (8) P00065; Spec. Cond. @ 25°C (9) P00095; Salinity °/oo (10) P00480; ...tage (11) P70211

CONDITION CODES

Weather Conditions (12) P00041; Flow Severity (13) P01351; ______ Severity (14) P013__; ______ Severity (15) P013__

NUTRIENTS

LEVEL ☐ HIGH ☐ LOW

NO2-N (16) P00615; NO2 + NO3 - N (17) P00630; NH3 - N (18) P00610; Tot. Kjeldahl N (19) P00625; Ortho-PO4 as P (20) P70507, as PO4 (21) P00660; Phosphorus-tot as P (22) P00665, as PO4 (23) P00650

BACTERIOLOGICAL – DILUTIONS (REQUESTED)

Fecal Coliform / Total Coliform; Fecal Streptococci; Fecal coli /100 ml MPN (24) P31615, MF (25) P31613; Fecal Strept MPN/100ml (26) P31677; Tot coli MPN/100 ml (27) P31505

BIOCHEMICAL OXYGEN DEMAND

INITIAL D.O. (lab.) ______ SAMPLE
SEED YES ☐ NO ☐
CONC. %
BOD
☐ BOD 5-DAY (28) P310, 6-DAY (29) P312

☐ COD (30) P340; ☐ TOC (31) P00680; ☐ Color Pt - Cou (32) P00080; ☐ Turbidity (33) P00076; ☐ Suspended Solids (34) P00530; ☐ Suspended Solids Ash (35) P00540; ☐ Tot. Solids (36) P00500; ☐ Tot. Solids - Ash (37) P00510; ☐ Tot. Dissolved Solids (TDS) (38) P70300

☐ pH (LAB) (39) P00403; ☐ Alkalinity as CaCO3 (40) P00410; ☐ Min. Acidity as CaCO3 (41) P00436; ☐ Chloride (42) P00940; ☐ MBAS (43) P38260; ☐ Phenols (44) P32730; ☐ Hardness - tot as CaCO3 (45) P00900; ☐ Sulfate (46) P00945; ☐ Oil & Grease (47) P00556; ☐ Petroleum Hydrocarbons (48) P45501; ☐ Cyanide (49) P00720

Parameter	Result
☑ As - tot ug/l (50) P01002	118
☑ Cd - tot ug/l (51) P01027	136
☐ Cr - tot ug/l (52) P01034	
☐ Cu - tot ug/l (53) P01042	
☐ Fe - tot ug/l (54) P01045	
☑ Hg - tot ug/l (55) P71900	0.54
☐ Mn - tot ug/l (56) P01055	
☑ Ni - tot ug/l (57) P01067	300
☑ Pb - tot ug/l (58) P01051	110
☑ Zn - tot ug/l (59) P01092	4000

ADDITIONAL ANALYSIS

☐ ______ P______
☐ ______ P______
☐ ______ P______
☐ ______ P______
☐ ______ P______

NLI 002 1100

RESULTS mg/l unless otherwise noted

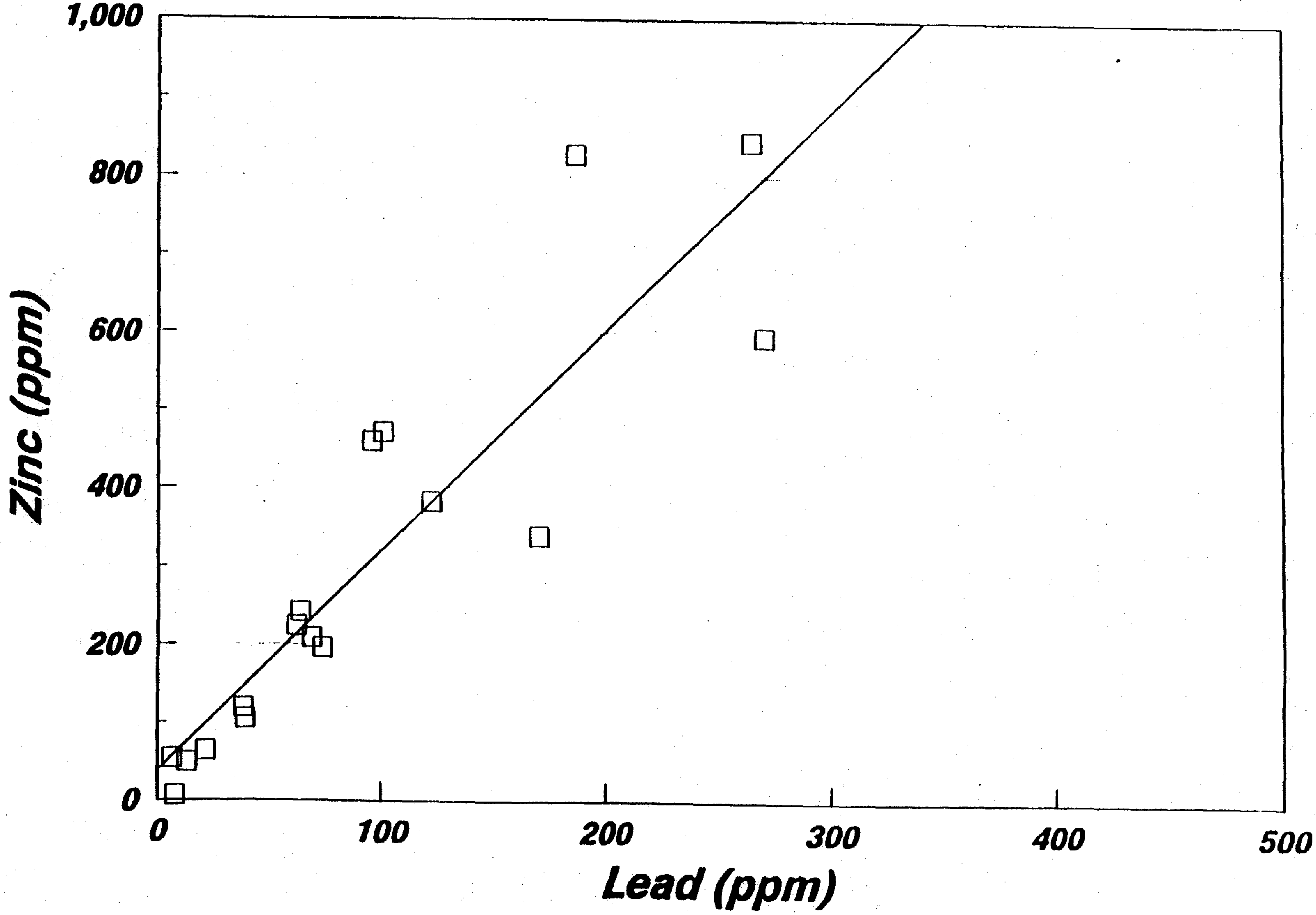
Chemist Review ______

Part 1 (White) - Water Quality Inventory Copy
Part 2 (Canary) - Laboratory Copy
Part 3 (Pink) - Laboratory Copy
Part 4 (Goldenrod) - Field Samplers Copy

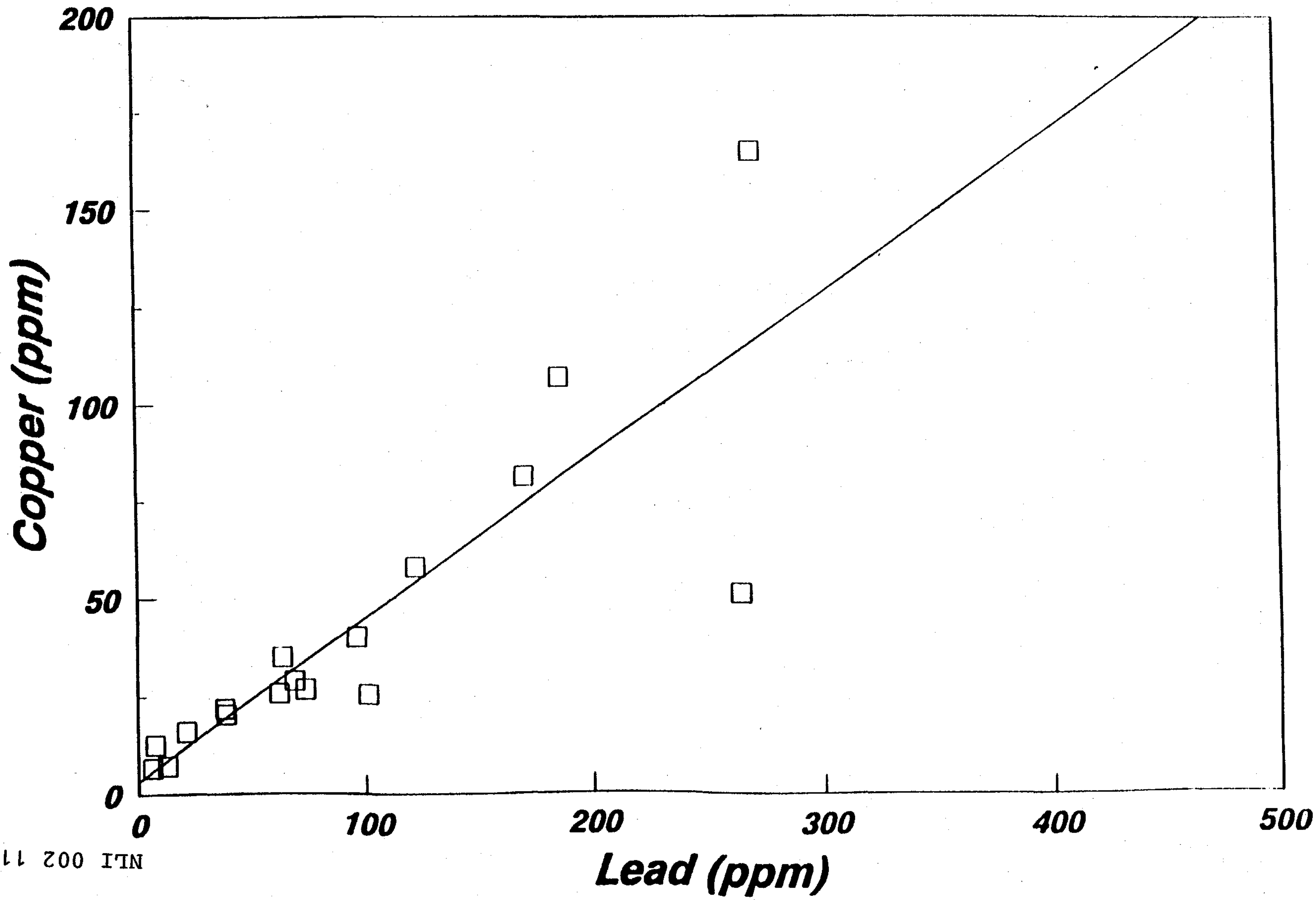
APPENDIX L

INORGANIC CONSTITUENTS IN SEDIMENT

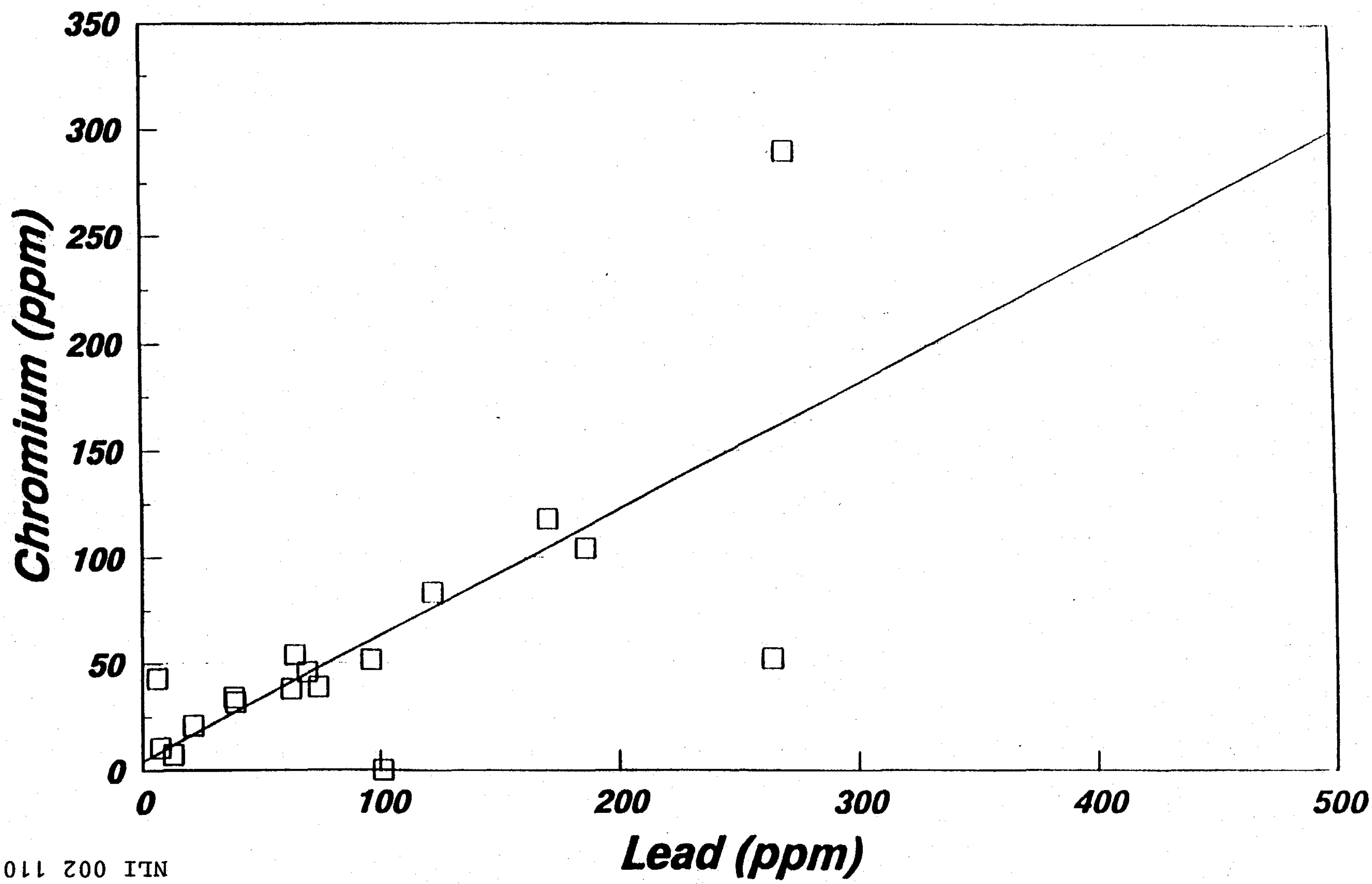
Lead vs. Zinc



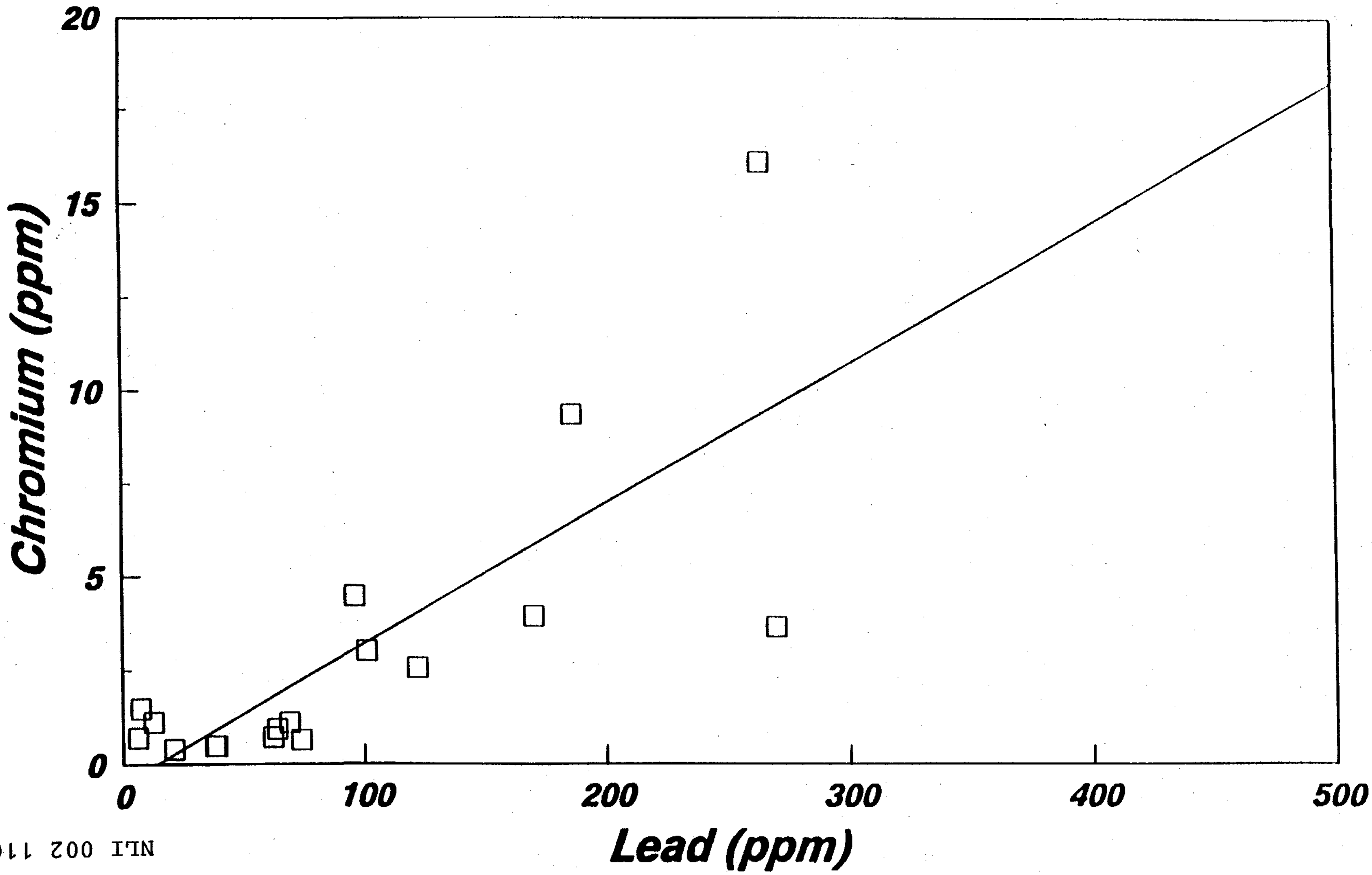
Lead vs. Copper



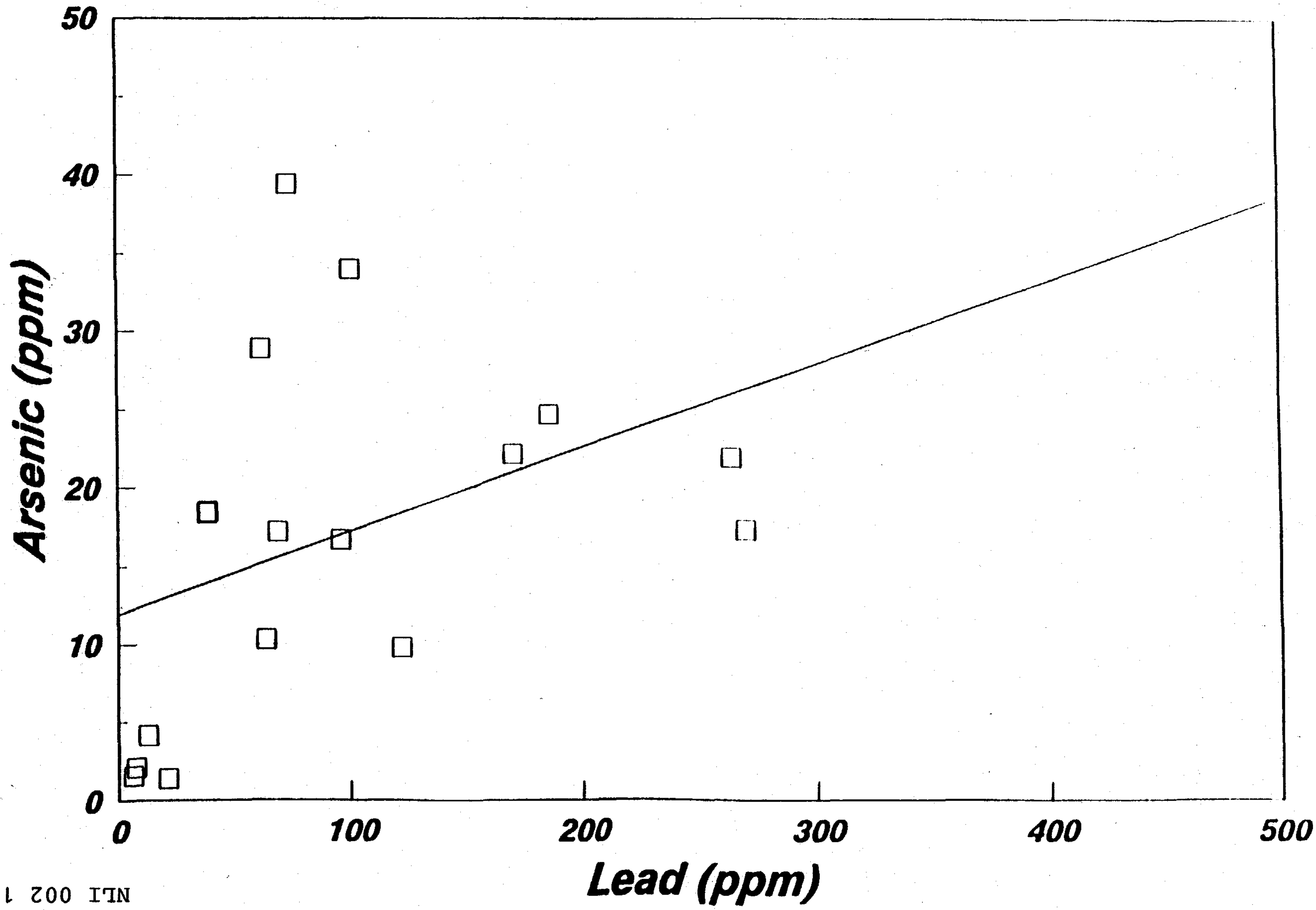
Lead vs. Chromium

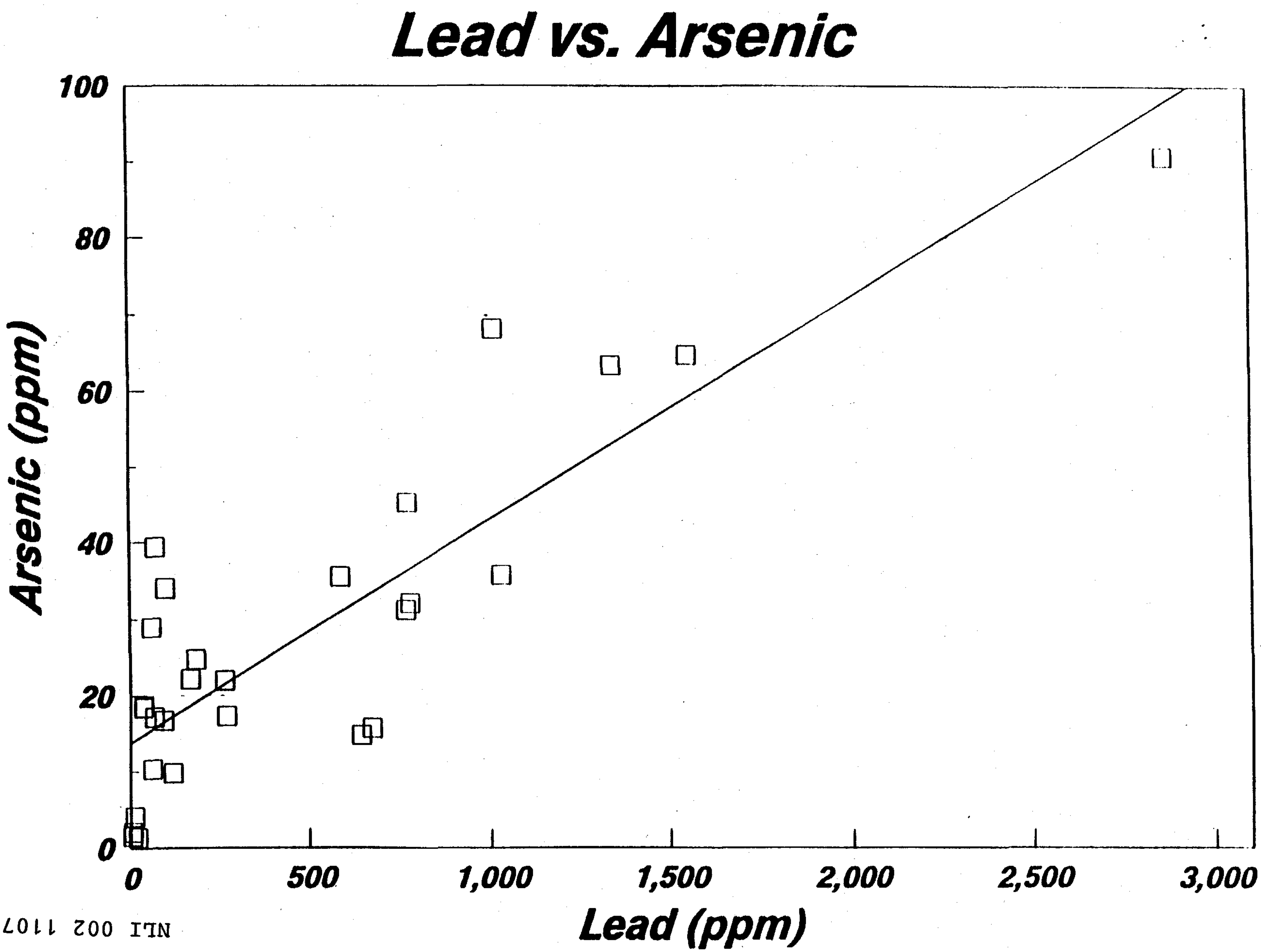


Lead vs. Cadmium

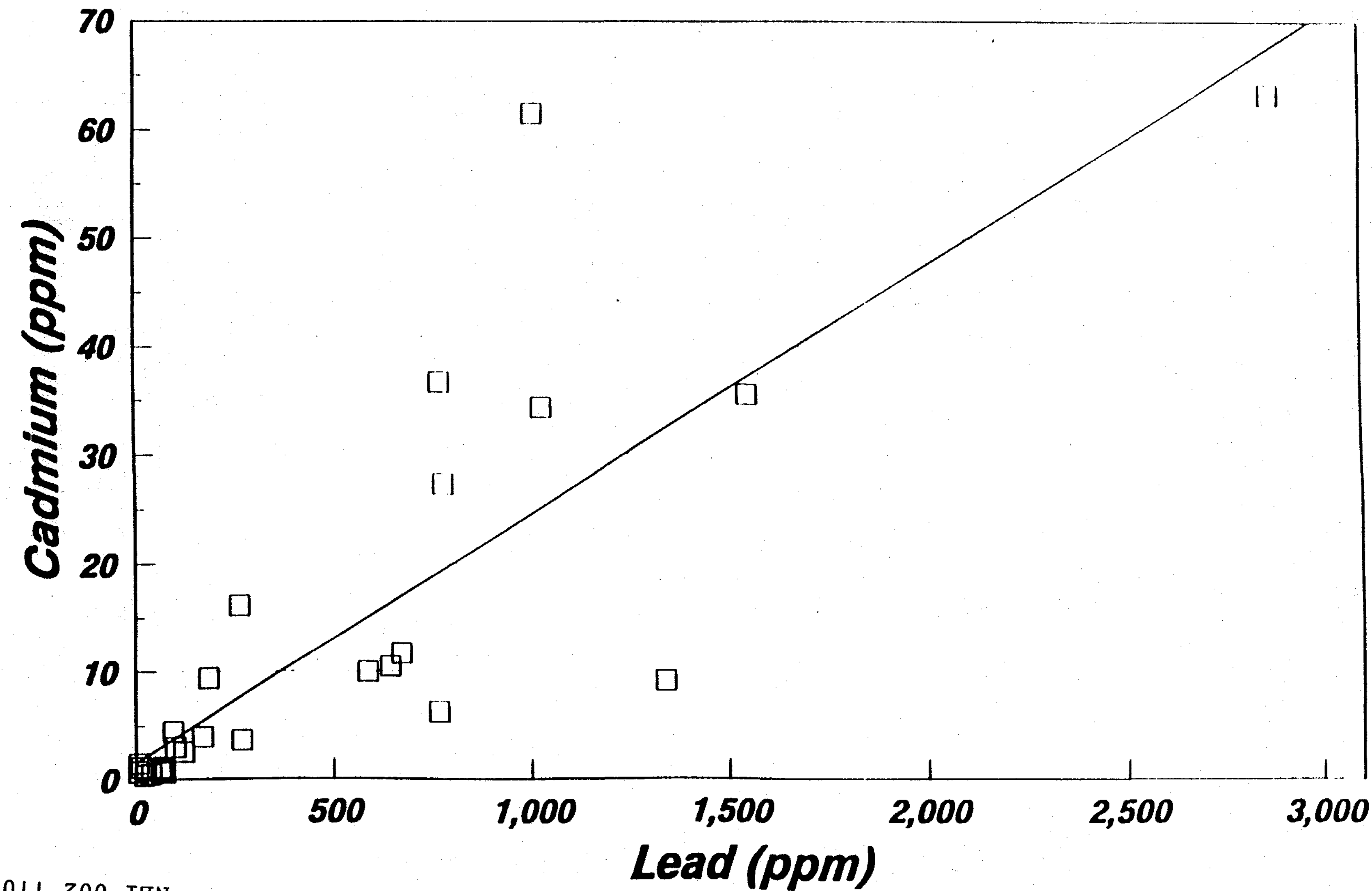


Lead vs. Arsenic

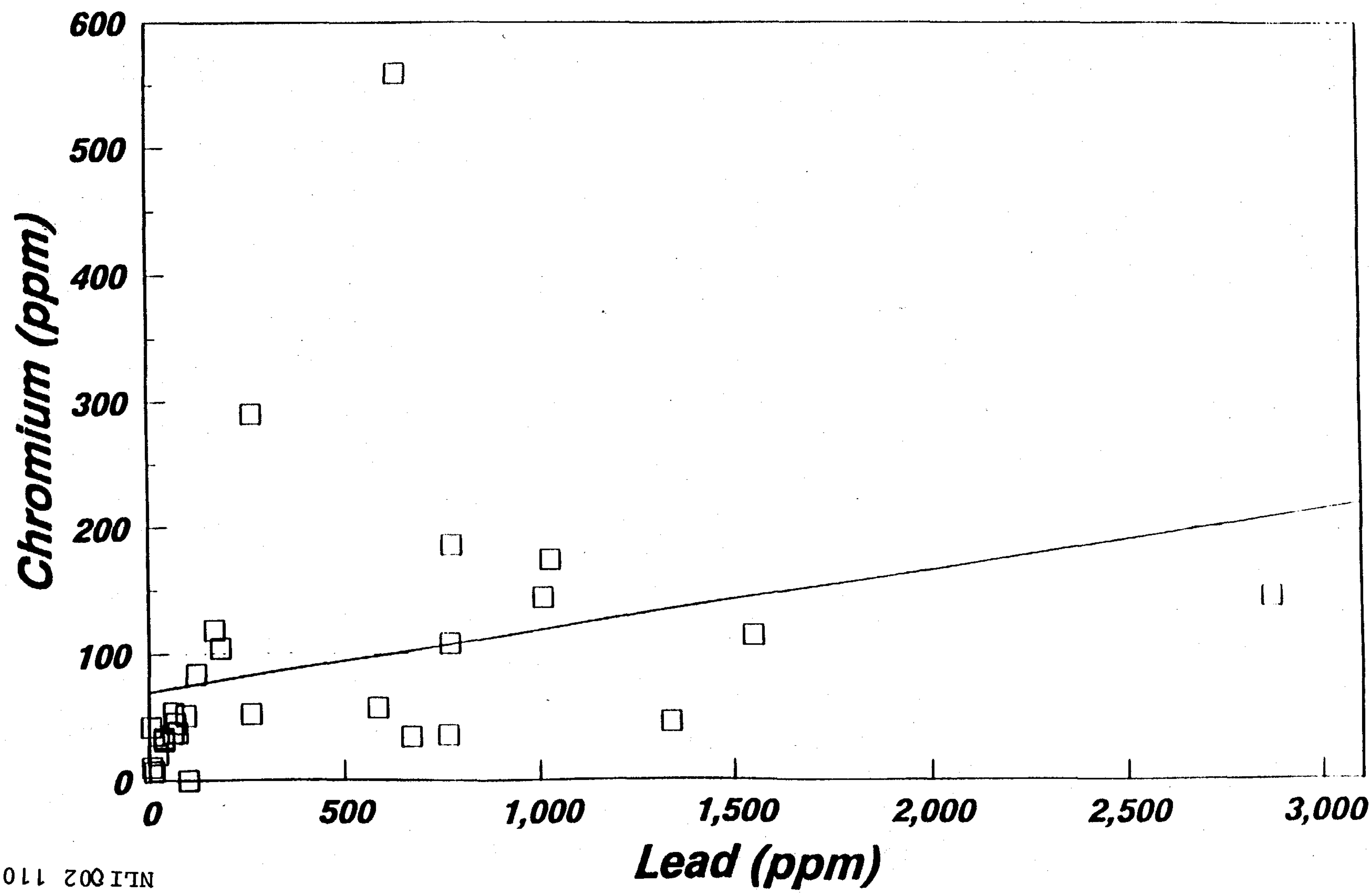



Lead vs. Arsenic
100
80
60
40
20
0
Arsenic (ppm)
0
500
1,000
1,500
2,000
2,500
3,000
Lead (ppm)

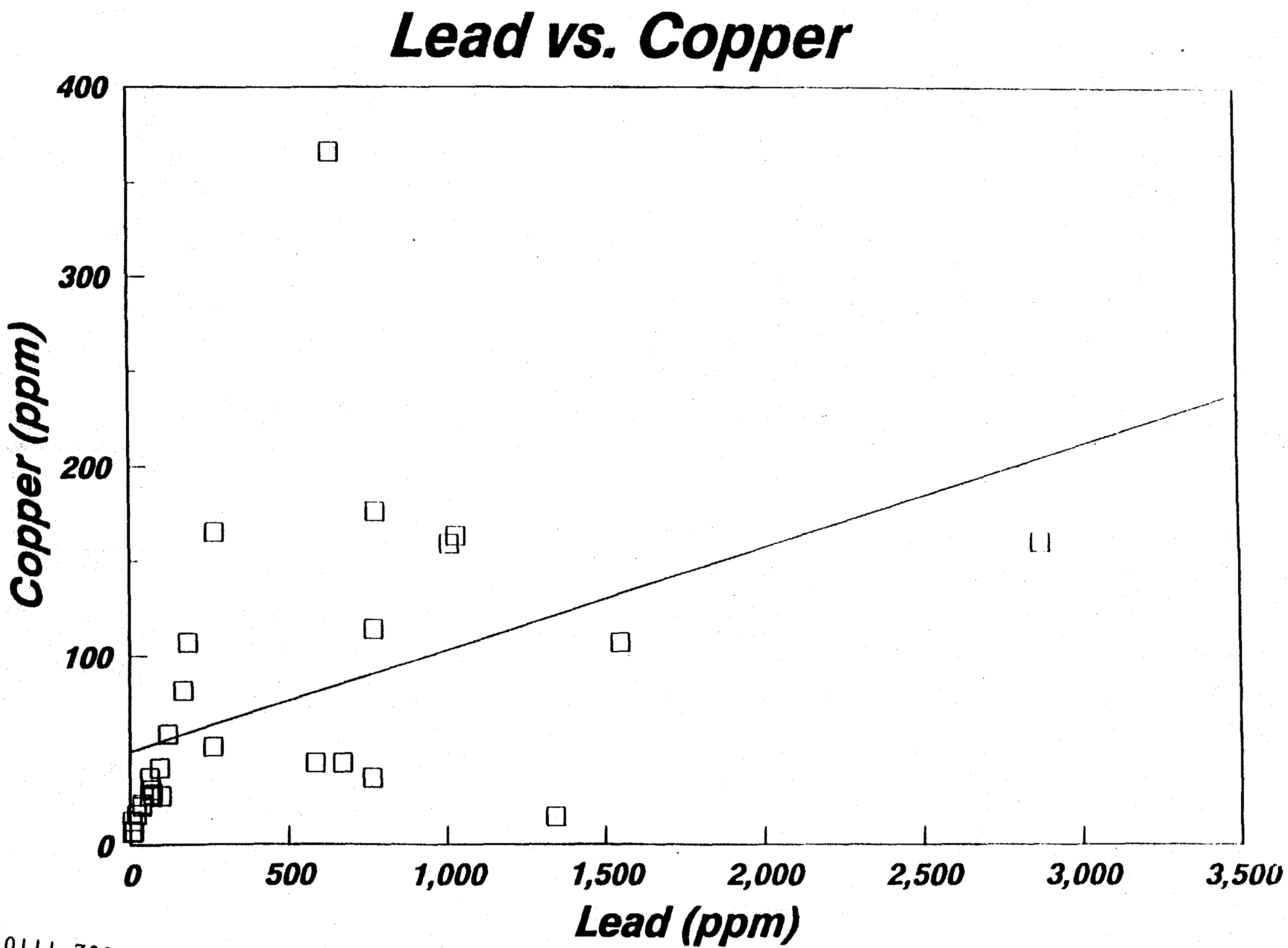
Lead vs. Cadmium



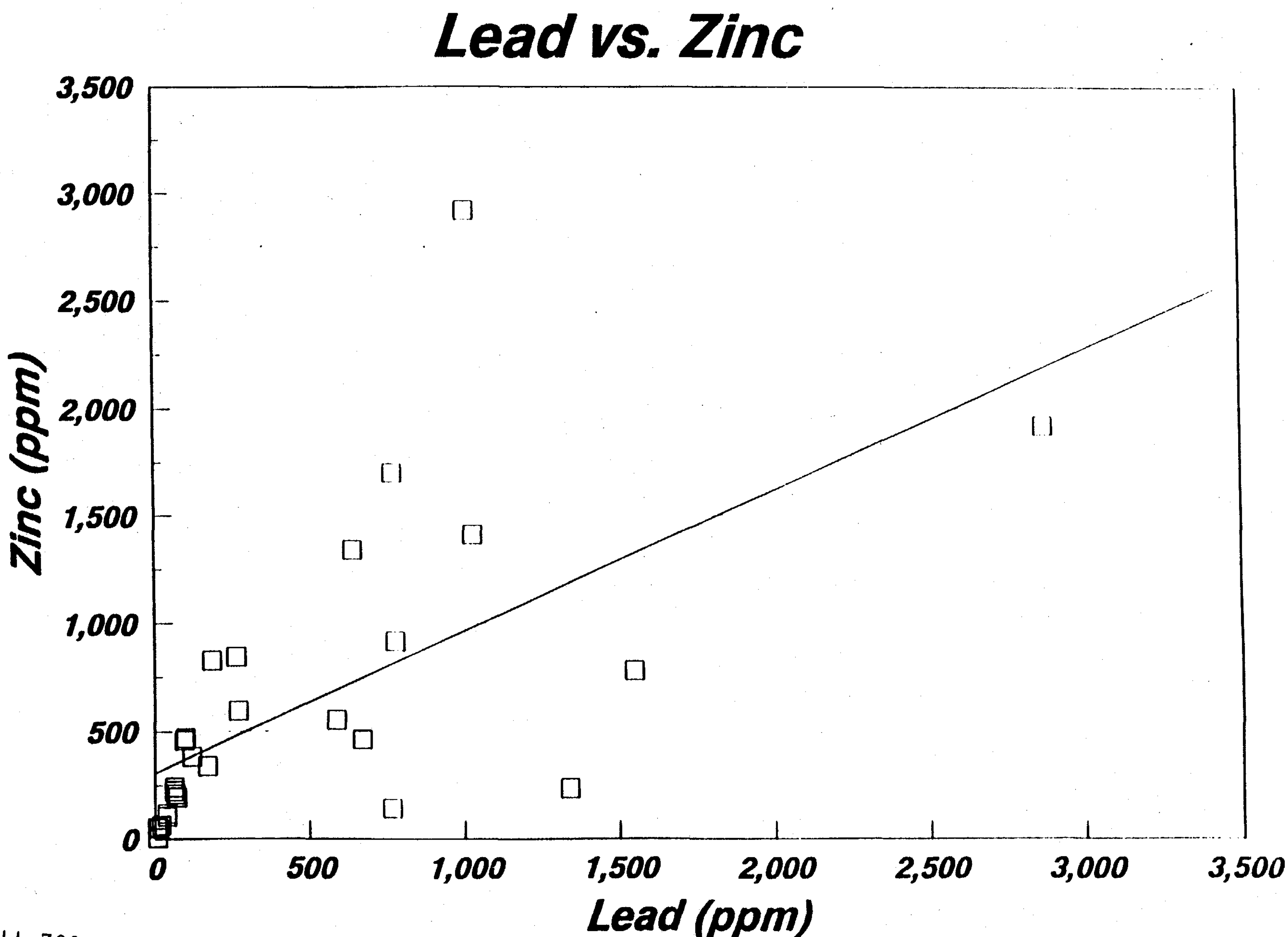
Lead vs. Chromium



NLI002 1109



Lead vs. Copper
400
300
200
100
0
Copper (ppm)
0
500
1,000
1,500
2,000
2,500
3,000
3,500
Lead (ppm)


Lead vs. Zinc
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Zinc (ppm)
0
500
1,000
1,500
2,000
2,500
3,000
3,500
Lead (ppm)

NLI 002 1111

APPENDIX M

WETLANDS EVALUATION TECHNIQUE - FUNCTIONAL VALUE ASSESSMENT

SECTION 1 - DESCRIPTION OF WETLAND EVALUATION TECHNIQUE (WET)

WET was developed by the U.S. Army Corps of Engineers and the Federal Highway Administration to assess the functions and values of wetlands. As requested by the U.S. EPA, the functions of wetlands occurring within the National Smelting of New Jersey (NSNJ) site and adjacent areas were assessed. The wetland areas of the NL site are divided into nine (9) assessment areas (AA's). According to the WET manual, "If detailed field measurements indicate a high degree of hydrologic interaction between two wetland/deepwater areas, include them in the same AA. If little or no evidence of hydrologic interaction is evident, delineate the wetland/deepwater areas as separate AA's." The above mentioned quote is a generalized statement. Further inspection of the WET manual reveals that additional factors which should be taken into consideration when determining Assessment Areas (AA's) include constrictions, fringe wetlands, non-fringe wetlands, and the input zone. The AA's within the study area are separated into nine (9) AA's based on physical and biological characteristics determined by extensive on-site field investigation, on-site analysis of surface lead concentrations, and as directed by the WET manual.

AA7, AA8, and AA9 show significant differences in lead concentrations within the AA's. The mean surface lead concentration (mg/kg) in AA7 is 2140.3, AA8 is 109.75 and in AA9 is 50.65 (Table S-8). AA1, AA2, AA3, and AA4 also show significant differences in surface lead concentrations within the AA's. The mean lead concentration (mg/kg) of AA1 is 27.2, AA2 is 63.25, AA3 is 191.32, and AA4 is 37.5 (Table S-8). The different locations of the AA's in relation to the landfill and upland areas, which contain elevated levels of lead, have significant impacts on the AA's in terms of sediment, nutrient, and/or contaminant input. The above mentioned lead concentrations are the basis for the separation of AA's 1, 2, 3, 4, 7, 8 and 9. The AA's being identified by lead levels allows each AA to be reviewed individually for impact to the AA from sediments, nutrients, or contaminant input.

The separation of AA7 from AA8 and AA9 is also due to constriction of the channel/floodplain to one-third, or less, the width of the widest upstream or downstream channel/floodplain as described in the WET manual.

WET was performed on each AA to evaluate the functions of ground water recharge; ground water discharge; floodflow alteration; sediment/toxicant retention; nutrient removal/transformation; production export; wildlife diversity/abundance for breeding, migration and wintering; and aquatic diversity/abundance.

The above mentioned functions were evaluated in terms of effectiveness and opportunity. WET describes effectiveness and opportunity as the following:

> "Effectiveness assess the capability of a wetland to perform a function due to its physical, chemical, and biological attributes. Effectiveness does not estimate the magnitude at which a function is performed, only the probability that a wetland will perform the function."
>
> "Opportunity assesses the chance or opportunity a wetland has to perform a function. For example, a wetland may possess the physical attributes required to perform floodflow alteration, but unless the wetlands is positioned in the watershed where it will receive floodflows it will not have the opportunity to perform the floodflow alteration function."

WET evaluates the functions of wetlands using predictors that are believed to correlate with the wetland and its surroundings in terms of physical, chemical, and biological characteristics. The conclusions drawn by WET are qualitative probability ratings of High, Moderate, or Low for function in terms of effectiveness and opportunity.

SECTION 2 - DESCRIPTION OF FUNCTIONS

A. Ground Water Recharge

Wetland areas which are considered effective ground water recharge systems are those in which the rate of recharge of water from the wetland to the ground water table typically exceeds the rate of recharge from terrestrial environments or wetland areas in which the recharge of water to underlying materials or ground water (deep or shallow) exceeds ground water discharge to the wet depression on a net annual basis.

B. Ground Water Discharge

Groundwater discharge is considered by WET to be those areas in which the rate of discharge from ground water (deep or shallow) into the wetland exceeds the recharge rate to groundwater underlying the wetland on a net annual basis.

C. Floodflow Alteration

WET considers areas in which surface water is stored or its velocity is attenuated to a greater degree than typically occurs in terrestrial environments to be capable of floodflow alteration.

D. Sediment Stabilization

Sediment stabilization is the ability of an area to bind soils and dissipate erosive forces more effectively than typical upland environments.

E. Sediment/Toxicant Retention

Areas which physically (or chemically in the case of toxicants) trap and retain the inorganic sediments and/or chemical substances generally toxic to aquatic life on an net annual basis are considered by WET to be High sediment/toxicant retention areas.

F. Nutrient Removal/Transformation

High nutrient removal/transformation areas are considered by WET to be those areas which retain or transform inorganic phosphorus and/or nitrogen into their organic forms or transform nitrogen into its gaseous form, either during the growing season or on a net annual basis. WET considers areas of High nutrient removal/transformation to be more effective at nutrient removal/transformation than typical upland environments.

G. Production Export

Production export is the ability of an area to flush organic plant material (specifically net annual primary production) from the AA into water downslope.

H. Aquatic Diversity/Abundance

For the purposes of WET, a High rating of an area means that, at least seasonally, a notably great on-site diversity of fish or invertebrates are supported by the AA.

I. Wildlife Diversity/Abundance for Breeding

WET determines whether, during the breeding season, the wetland normally supports a diversity and/or abundance of wetland-dependent birds.

J. Wildlife Diversity/Abundance for Migration and Wintering

WET determines if, during migration or winter, the wetland of the AA supports on-site diversity and/or abundance of wetland-dependent avifauna.

SECTION 3 - EVALUATION OF THE ASSESSMENT AREAS

3.01 General

Due to all the assessment areas being within the same geological area, some functions remain consistent. The functions of the assessment areas which remain constant for effectiveness are ground water discharge, production export, and wildlife diversity/abundance for breeding and wintering. The functions of the assessment areas which remain constant for opportunity are floodflow alteration and sediment/toxicant retention.

A. EFFECTIVENESS

A Low or Uncertain rating was given to all the assessment areas for ground water recharge. According to the WET operational manual, most eastern wetlands will receive a Low or Uncertain rating for ground water recharge.

The ground water discharge rating for all of the assessment areas was Low. Due to the wetland areas being non-permanently inundated and their location in an area without a precipitation deficit, the probability of the wetlands to function as ground water discharge areas is Low.

All the assessment areas were given a High or Moderate rating by the WET program for effectiveness in floodflow alteration. Due to slight topographical changes occurring throughout the project area, the wetlands are broad and have the ability to retain/store floodwater and intercept floodflow from areas higher in the watershed.

All of the wetlands assessed in this study have an outlet through which water exits the site. Some of the outlets are constricted causing water to back up in times of heavy rain and one assessment area has an outlet through which water flows only if the level of water in the AA is greater than the elevation of its outlet. All the AA's have outlets, significant areas of erect emergent vegetation, and the potential for expansive flooding. Due to the presence of the above mentioned characteristics, the rating given by WET for production export is Moderate for all AA's.

The types of wetlands which occur within the project area, their vegetation, size, geographic location, potential to receive toxic material, and surrounding land use are considered by WET in the determination of Wildlife Diversity/Abundance for breeding. The probability of the AA's to support a diverse and abundant array of breeding birds was found by WET to be Moderate for all the AA's.

A Low rating was given to all of the AA's for probability in providing a winter habitat for water-dependent birds. The relatively small size of the wetlands plays a role in the conclusions drawn by WET.

B. OPPORTUNITY

The opportunity rating given by WET for floodflow alteration was Moderate for all AA's. The potential of the AA's to intercept floodflow was average due to their palustrine classification, the size of the watershed in comparison to the AA's size, and the nature of the underlying substrate and its filtration rate.

Due to the occurrence of a known source of contamination near the AA's, they have a High probability to have the opportunity to trap sediments which may be environmentally sensitive.

3.02 ASSESSMENT AREA 1 (AA1)

Area AA1 includes the east stream from Route 130 to the intersection of east stream and the tributary to the west. Due to the wastewater discharge from B.F. Goodrich, the rate of flow within the AA is constant and moderate to low, depending on storm events and rate of flow from B.F. Goodrich. The WET analysis, summarized in the NSNJAA1 table, identified the AA as High effectiveness for: floodflow alteration, sediment/toxicant retention, nutrient removal/transformation, wildlife diversity/abundance for migration, and aquatic diversity/abundance. A Low rating for effectiveness was assigned by WET for: ground water discharge and wildlife diversity/abundance for wintering. A more complete description follows.

Interpretation of WET shows that AA1 effectively binds the soil and dissipates erosive forces, thereby effectively stabilizing the sediment within the AA. Constriction of the outlet for AA1, slow-velocity flow, and erect vegetation very effectively trap and retain inorganic sediments and/or chemical substances generally toxic to aquatic life on a net annual basis.

AA1 was found to be very effective in retention or transformation of inorganic phosphorus and/or nitrogen into their organic forms and/or, in the case of nitrogen, into its gaseous form. The presence of an inlet in which surface flow is present and a constricted outlet play a role in the ability of the AA to function very effectively in nutrient removal/transformation. The opportunity for AA1 to retain nutrients was found to be Moderate due to the permanent inlet and the size of the AA in comparison to the watershed.

WET found AA1 to be very effective in providing habitat to migrating wetland-dependent birds. AA1 was also found to be very effective in providing habitat for a diverse population of invertebrates and/or fish due to the presence of water within the AA throughout the year.

3.03 ASSESSMENT AREA 2 (AA2)

AA2 consists of the southern portion of the western tributary of east stream from the intersection of AA1 and AA3 to the property boundary. AA2 contains an intermittent stream in which flow occurs only during the early portion of the growing season and immediately after rain events. The functions, summarized in the NSNJAA2 table, which were identified as High in terms of effectiveness by the WET analysis are: floodflow alteration, sediment/toxicant retention, and nutrient removal/transformation. AA2 was considered to have Low effectiveness for: ground water recharge, ground water discharge, and wildlife diversity/abundance for migration and wintering. A more complete description follows.

Interpretation of WET shows that AA2 effectively binds the soil and dissipates erosive forces, thereby effectively stabilizing the sediment within the AA. Constriction of the outlet for AA2, slow-velocity flow, and erect vegetation very effectively trap and retain inorganic sediments and/or chemical substances generally toxic to aquatic life on a net annual basis. AA2 was found to be very effective in retention or transformation of inorganic phosphorus and/or nitrogen into their organic forms and/or, in the case of nitrogen, into its gaseous form. Although AA2 functions as a very effective wetland in terms of nutrient removal/transformation, the opportunity of AA2 to perform these functions was found to be Low due to the lack of a permanent inlet.

The ability of AA2 to provide habitat for migrating wetland-dependent birds was Low due to the lack of available open-water within the AA.

AA2 was found to function as an average wetland in terms of providing habitat for aquatic invertebrates and/or fish. Portions of AA2 have little or no flow during the drier seasons, thereby limiting the amount of time in which the wetland offers habitat for aquatic diversity/abundance.

3.04 ASSESSMENT AREA 3 (AA3)

AA3 is located upstream (south) of the intersection of east stream and the tributary to the west (AA1). AA3 includes the area in which the wastewater is discharged from B.F. Goodrich. The flow rate of AA3 is slow during most of the year and moderate downstream of the wastewater discharge area during storm events. AA3 is intermittent upstream of the wastewater discharge area and continuous below the discharge area. The functions of the AA and their ratings are summarized in the NSNJAA3 table. The area of High effectiveness, as identified by the WET analysis, for AA3 is: Wildlife diversity for migration. AA3 was considered to have Low effectiveness for: ground water recharge, ground water discharge, nutrient removal/transformation, and wildlife diversity/abundance for wintering. A more complete description follows.

Interpretation of WET shows that AA3 effectively binds the soil and dissipates erosive forces, thereby effectively stabilizing the sediment within the AA. Field investigation of AA3 did not reveal the presence of a constricted outlet. Although erect vegetation and low-velocity flow occur within AA3, the lack of a constricted outlet provides an ineffective environment for trapping and retaining inorganic sediment and/or chemical substances generally toxic to aquatic life on a net annual basis. AA3 is located upstream of AA1 (Figure 1) which is rated as High in sediment/toxicant retention. Although the inorganic sediment and/or chemical substances will not be retained in AA3, retention in AA1 is likely.

AA3 was found to be ineffective in nutrient removal/ transformation. According to the WET operational manual, areas are rated Low for nutrient removal if they are also rated Low for sediment trapping and have no woody or floating-leaved vegetation. Due to the inlet of the AA being intermittent, the opportunity of AA3 to perform nutrient removal/transformation processes is Low.

WET found AA3 to be very effective in providing habitat to migrating wetland-dependent birds due to broad, flat areas of open water being present during migration season. AA3 was found to function as an average wetland in terms of providing habitat for aquatic invertebrates and/or fish. Portions of AA3 have little or no flow during the drier seasons, thereby limiting the amount of time in which the wetland offers habitat for aquatic diversity/abundance.

3.05 ASSESSMENT AREA 4 (AA4)

South of AA3 is an area which is hydrologically connected to AA3 by a small area of low elevation. The AA is isolated from the adjacent wetland community except during major rain events which cause the elevation of the surface water within the AA to reach and exceed the elevation of the outflow. The only time when water flows in the AA is in the above mentioned situations. The WET analysis, summarized in the NSNJAA4 table, identified the AA as having High effectiveness for: floodflow alteration and sediment/toxicant retention. Low ratings for effectiveness were assigned for: ground water discharge, nutrient removal/ transformation, wildlife diversity/abundance for migration and wintering, and aquatic diversity/abundance. A more complete description follows.

Interpretation of WET shows that AA4 effectively binds the soil and dissipates erosive forces, thereby effectively stabilizing the sediment within the AA. Constriction of the outlet for AA4, slow-velocity flow, and erect vegetation very effectively trap and retain inorganic sediments and/or chemical substances generally toxic to aquatic life on a net annual basis. AA4 was found to be ineffective in nutrient removal/ transformation. The lack of velocity, ditches or channels within the AA effects the ability of the AA to perform nutrient removal/ transformation processes. Due to the inlet of the AA being intermittent, the opportunity of AA4 to perform nutrient removal/ transformation processes is Low.

The ability of AA4 to provide habitat for migrating wetland-dependent birds was Low due to the lack of available open-water within the AA.

Habitat for a diverse population of invertebrates and/or fish was not found to be available in AA4 due to the AA being isolated from adjacent wetland areas except during times of exceptionally high rainfall.

3.06 ASSESSMENT AREA 5 (AA5)

Area AA5 is located on the east side of the landfill on the northern and southern sides of the railway easement. The two portions of the AA are hydrologically connected by a culvert which is located under the railway easement. The rate of flow within and from the AA is slow and intermittent. Summarization of the functions of AA5 is contained in the NSNJAA5 table. Areas of high effectiveness identified by WET are: sediment stabilization and sediment/toxicant retention. Low ratings for effectiveness were assigned by WET to: ground water recharge, ground water discharge, nutrient removal/transformation, wildlife diversity/abundance for migration and wintering, and aquatic diversity/abundance. A more complete description follows.

The effectiveness of AA5 to bind the soil and dissipate erosive forces is High due to the AA being unsheltered with erect vegetation. Constriction of the outlet for AA5, slow-velocity flow, and erect vegetation very effectively trap and retain inorganic sediments and/or chemical substances generally toxic to aquatic life on a net annual basis.

AA5 was found to be ineffective in nutrient removal/ transformation. The lack of velocity, ditches or channels within the AA effects the ability of the AA to perform nutrient removal/ transformation processes. Due to the inlet of the AA being intermittent, the opportunity of AA5 to perform nutrient removal/ transformation processes is Low.

The ability of AA5 to provide habitat for migrating wetland-dependent birds was Low due to the relatively small size of the AA and its lack of a permanent outlet.

Habitat for a diverse population of invertebrates and/or fish was not found to be available in AA5 due to the AA being isolated from adjacent wetland areas during most of the year.

3.07 ASSESSMENT AREA 6 (AA6)

AA6 is located in the southeastern corner of the NSNJ site adjacent to the Pennsgrove-Pedricktown Road. The flow rate from the AA is slow and intermittent. As shown by the NSNJAA6 table, WET identified the functions of AA6 which are rated High for effectiveness as: floodflow alteration, sediment/toxicant retention, and nutrient removal/transformation. A Low rating was assigned by the WET analysis to: ground water discharge, wildlife diversity/abundance for migration and wintering, and aquatic diversity/abundance. A more complete description follows.

Interpretation of WET shows that AA6 effectively binds the soil and dissipates erosive forces, thereby effectively stabilizing the sediment within the AA. Constriction of the outlet for AA6, slow-velocity flow, and erect vegetation very effectively trap and retain inorganic sediments and/or chemical substances generally toxic to aquatic life on a net annual basis. AA6 was found to be very effective in retention or transformation of inorganic phosphorus and/or nitrogen into their organic forms and/or, in the case of nitrogen, into its gaseous form. Although AA6 functions as a very effective wetland in terms of nutrient removal/transformation, the opportunity of AA6 to perform these functions was found to be Low due to the lack of a permanent inlet.

The ability of AA6 to provide habitat for migrating wetland-dependent birds was Low due to the lack of available open-water within the AA.

Habitat for a diverse population of invertebrates and/or fish was not found to be available in AA6 due to the AA being isolated from adjacent wetland areas during most of the year.

3.08 ASSESSMENT AREA 7 (AA7)

Area AA7 is located on the western portion of the site and extends from the Pennsgrove-Pedricktown Road north to the railway easement. The flow within the AA is slow and intermittent. Analysis performed by WET and summarized in the NSNJAA7 table found the AA to perform the following functions with High effectiveness: floodflow alteration and sediment/toxicant retention. The functions of the AA which were identified as Low for effectiveness are: ground water recharge, ground water discharge, nutrient removal/transformation, and wildlife diversity/abundance migration and wintering. A more complete description follows.

Interpretation of WET shows that AA7 effectively binds the soil and dissipates erosive forces, thereby effectively stabilizing the sediment within the AA. Constriction of the outlet for AA7, slow-velocity flow, and erect vegetation very effectively trap and retain inorganic sediments and/or chemical substances generally toxic to aquatic life on a net annual basis.

AA7 was found to be ineffective in nutrient removal/ transformation. The lack of velocity within the AA effects the ability of the AA to perform nutrient removal/transformation processes. Due to the inlet of the AA being intermittent, the opportunity of AA7 to perform nutrient removal/transformation processes is Low.

The ability of AA7 to provide habitat for migrating wetland-dependent birds was Low due to the lack of available open-water within the AA.

AA7 was found to function as an average wetland in terms of providing habitat for aquatic invertebrates and/or fish. Portions of AA7 have little or no flow during the drier seasons, thereby limiting the amount of time in which the wetland offers habitat for aquatic diversity/abundance.

3.09 ASSESSMENT AREA 8 (AA8)

AA8 is located in the western portion of the site north of the railway easement. AA8 is hydrologically connected to AA7 by a culvert which is located under the railway easement. The rate of flow within the AA is slow during the most of the year and moderate during times of storm events. The NSNJAA8 table summarizes all of the functions and their ratings. The function identified by the WET analysis as being performed with High effectiveness is floodflow alteration. The functions identified as being performed with Low effectiveness are: groundwater discharge, sediment/toxicant retention, nutrient removal/ transformation, and wildlife diversity/abundance for migration and wintering. A more complete description follows.

Interpretation of WET shows that AA8 effectively binds the soil and dissipates erosive forces, thereby effectively stabilizing the sediment within the AA. Field investigation of AA8 did not reveal the presence of a constricted outlet. Although erect vegetation and low-velocity flow occur within AA8, the lack of a constricted outlet provides an ineffective environment for trapping and retaining inorganic sediment and/or chemical substances generally toxic to aquatic life on a net annual basis. AA8 is located upstream of AA9 (Figure 1) which is rated as High in sediment/toxicant retention. Although the inorganic sediment and/or chemical substances will not be retained in AA8, retention in AA9 is likely.

AA8 was found to be ineffective in nutrient removal/ transformation. According to the WET operational manual, areas are rated Low for nutrient removal if they are also rated Low for sediment trapping and have no woody or floating-leaved vegetation. Due to the permanent inlet of the AA, the opportunity of AA8 to perform nutrient removal/transformation processes is Moderate.

The ability of AA8 to provide habitat for migrating wetland-dependent birds was Low du(to the lack of available open-water within the AA.

AA8 was found to function as an average wetland in terms of providing habitat for aquatic invertebrates and/or fish. Portions of AA8 have little or no flow during the drier seasons, thereby limiting the amount of time in which the wetland offers habitat for aquatic diversity/abundance.

3.10 ASSESSMENT AREA 9 (AA9)

Area AA9 is located in northwestern portion of the site. AA9 extends north of AA8 to Route 130. The rate of flow in the AA is slow under normal conditions and moderate during storm events. The WET analysis, summarized in the NSNJAA9 table, identified the following functions as being performed with High effectiveness: floodflow alteration, sediment/toxicant retention, nutrient removal/transformation, and aquatic diversity/abundance. A rating of Low for effectiveness was assigned to the following functions: ground water discharge, and wildlife diversity/abundance for migration and wintering. The NSNJAA9 table summarizes all of the functions and their ratings.

Interpretation of WET shows that AA9 effectively binds the soil and dissipates erosive forces, thereby effectively stabilizing the sediment within the AA. Constriction of the outlet for AA9, slow-velocity flow, and erect vegetation very effectively trap and retain inorganic sediments and/or chemical substances generally toxic to aquatic life on a net annual basis.

AA9 was found to be very effective in retention or transformation of inorganic phosphorus and/or nitrogen into their organic forms and/or, in the case of nitrogen, into its gaseous form. The presence of an inlet in which surface flow is present and a constricted outlet play a role in the ability of the AA to function very effectively in nutrient removal/transformation. The opportunity for AA9 to retain nutrients was found to be

Moderate due to the permanent inlet and the size of the AA in comparison to the watershed.

The ability of AA9 to provide habitat for migrating wetland-dependent birds was Low due to the lack of available open-water within the AA. AA9 was found to be very effective in providing habitat for a diverse population of invertebrates and/or fish due to the presence of water in the AA throughout the year.

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